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COMMONWEALTH SCIENTIFIC CONFERENCE, 1946

IN the middle of next month, London will have occasion to welcome representative scientists from every part of the British Commonwealth; the Conference of Commonwealth Scientists, which has been arranged in close consultation of the Royal Society, is scheduled to commence its deliberations in the middle of June, and is expected to continue its sittings until the end of July. The official conference of the Commonwealth Government Delegates, proposed to be held in London, will be immediately preceded by the Royal Society Conference. The two conferences are intended to be complementary; the Royal Society Conference will, in general, deal with the scientific subjects under discussion while the official conference will consider also problems pertaining to matters of an administrative and organisational character.

The war-time experience of inter-imperial and transcontinental scientific collaboration, which shortened the war and led to its victorious end, is now to be consolidated and fully mobilised in the work of rehabilitation and reconstruction which faces every part of the globe; in the achievement of this stupendous task, the aid of science will have to be invoked in a far greater measure. The aftermath of the war has been widespread and devastating; the world is threatened with spectre of famine and pestilence with all the ugly consequences of malnutrition, disease and death. Apart from taking certain palliative measures to alleviate the immediate suffering, a long-range plan of concerted action is essential for removing all causes which lead to a frequent recrudescence of these misfortunes. In other words, the problems of crop production, nutrition and public health, industrial prosperity and national security, have to be considered and solved at the international level, if results of any value of permanence are to be secured in a reasonably short period. If all the nations could help to pool together their scientific knowledge and technical experience the speed of reconstruction could be augmented; and the Commonwealth Scientific Conference which has been organised is a step which will promote the cause of reconstruction. It is a matter of supreme satisfaction that a delegation of distinguished scientists from India is participating in the Commonwealth Conference.

The subjects which will come up for discussion have a common interest to all the participating units of the Commonwealth. Soil erosion and conservation, the taming of rivers and irrigation, conservation and exploitation of forests and fisheries, nutrition and public health, improvements of plants and animals, industrial utilisation of the mineral resources and natural products, harnessing the fuel and power resources—these are problems of universal importance; they have been tackled more or less successfully by most of the countries depending upon the availability of scientific knowledge and technical proficiency. A discussion of these problems and their attempted solutions by different groups of scientists at a common table, will not fail not only to reveal many points of common interest and but also lead to improved and co-operative methods of solving these problems in a manner which might ultimately prove more efficient and economical.

The Conference will naturally devise the administrative machinery through which the necessary collaboration could be secured. The mutual establishment of liaison officers in all parts of the Commonwealth and also in some of the advanced countries will serve to set in motion this great experiment in collaboration. Exchange of technical information, movement of technical personnel from one part of the Commonwealth to another, training of technical experts, are some of the outstanding problems which will no doubt be discussed at the forthcoming Conference.

The Conference constitutes an enterprising and commendable experiment in inter-Commonwealth collaboration for solving problems of common interest, and if successful, the experiment will no doubt be extended on an

international scale. It contains the seed through which nations will realise the value of collaborative effort in the common cause of establishing the four freedoms for which the second global war has been fought. Men of goodwill the world over will watch the proceedings of the Conference with the keenest interest and wish it an unqualified success.

FAZLI-OMAR RESEARCH INSTITUTE, QADIAN

ON the occasion of the Opening Ceremony of the Fazli-Omar Research Institute, Qadian, on the 19th April 1946, Dr. Sir Shanti Swarup Bhatnagar, O.B.E., F.R.S., Director, Scientific and Industrial Research, Government of India, declared :—

"When the Hon'ble Justice Sir Zafarullah Khan spoke to me in Delhi of the step which the Ahmadiyya community, under the inspiration of Hazrat Khalifatul Masih, had taken in providing funds for the Fazli-Omar Research Institute, I felt deeply touched. It appeared to me as a symbol of the acceptance of the method of science by a great religious leader. Sir Zafarullah humourously remarked that in choosing me for this honour, he had specially in mind the spiritual elevation of an old friend whom science had cut off completely from religion. I readily accepted the invitation as I did not wish to miss the opportunity of seeing this forward little town. I also very thoroughly appreciate the honour which this ceremony has offered me of coming into contact with Hazrat Khalifatul Masih. This is a privilege which I had cherished for a long time and its fulfilment to-day will never be forgotten by me. It will be a source of inspiration to me in my own arduous task of developing scientific and industrial research in India.

In selecting Dr. Abdul Ahad as the first Director of the Fazli-Omar Research Institute, your choice has fallen on one who combines in him the zeal for scientific research with great devotion to religion. I am much impressed by his vast knowledge of contemporary science. I am particularly happy that he has quoted in his speech the last words in a recent broadcast of mine on the subject of the Scientists' Utopia: "It looks certain that in the utopia of scientists God and Science will be brought into a fertile union in which the idea of God instead of being diluted will be enriched." This is my conviction and also the belief of a great many top-rank scientists of the world. The scientist to-day is not the hot-headed, blasphemous and conceited fellow which he used to be sometime ago. Physics has merged into metaphysics. The pride of the scientist has been humbled to such an extent that he no longer contends that science can explain even all that meets the eye. Amongst the prominent scientific workers of the world one would hardly find one who may be considered as a complete athiest. Numerous proofs that both science and religion are devotees of truth and righteousness can be quoted. The fact, Sir, that you, the religious head of a powerful community, have decided to make the Fazli-Omar Research Institute, a part of education of your programme of the religious development of your people, is nothing else but an indication of the direction in which the wind is blowing. Religious leaders no longer look upon science as antagonistic to their creeds. Such a unification of religion and science and such contacts between religion and science as your Institute will establish, are no doubt to be very much appreciated. The spirit of tolerance and forbearance gets developed not by remaining aloof but by intimate contacts and social mixing and I, therefore, wish this Institute a long life of great usefulness.

Religion has sought in all ages to unite people and to bring them in tune with the spiritual side of the Universe. It has been established, however, that the physical well-being of man is important for even the development of his soul and mind and it has, therefore, been the policy of religious leaders lately to see that their followers have a better and higher standard of living. Nothing can raise the standard of living of people more than science and education and I have no doubt that the future and present generations of Qadian will remember with gratitude the philanthropists and workers associated with the founding of this Institute of which you have asked me to perform the inaugural ceremony to-day.

I hope the scope of this Institute will be broad enough and that it will include in its activities all those branches of learning which may have a direct bearing on the economic well-being of the people of this town and incidentally of the whole country. Subjects such as nutrition can be tackled by you with great advantage and the nearness of such industrial centres as Sialkot and Amritsar will give you ample opportunities of attracting industrial research of local interest. I must, however, warn you that research institutes are very expensive hobbies and that unless sufficient funds are at your disposal, your activities are likely to suffer. I hope that your community and the local and Central Governments and the Industry will come to your aid. To bring into being such an institution and then not to provide sufficient funds is like the underfeeding of a sturdy baby or the treatment of a patient suffering from malaria with insufficient quinine.

Your Institute is perhaps the second of its kind in India. I think the first one, if I am not mistaken, is the Technical Institute at Dyal Bagh in Agra which owes its origin to the far-sightedness of the late Sir Anand Swarup, one of the leaders of the Radha Swami Movement. That Institute has done yeoman service to the cause of technical education and industrial development in India. I do hope and pray that your efforts may result even in greater achievement.

There are two things which I particularly wish to emphasise on this occasion. Firstly, that no applied research can flourish if isolated from pure research. The huge physical body of applied research is kept alive and fit by a constant supply of new blood in the shape of fundamental research of a pure character. Let

not the enthusiasm of those interested in immediate results of a purely utilitarian character carry you away from the path of your right duty to science. India needs both pure and applied research and you should never deviate from this happy combination. Applied research may be compared to the social urge of building mosques and temples, but what use is a mosque unless the individuals and masses are imbued with the true spirit of prayer? Pure research supplies the urge for new developments and new fields of applications and it should not be allowed to be neglected, even though we might insist upon greater expenditures being allotted to applied work.

The second thing which I consider necessary is the proper education of the scientist. In America the emphasis on humanities had decreased to such an extent that the much dreaded monster-scientist was beginning to be envisaged. Fortunately, the Americans realised that the labour-saving devices of science will soon give so much leisure to man that his brain will become a devil's workshop and, therefore, they have begun to lay greater emphasis on the compulsory introduction of courses of studies in humanity in the scientists' and engineers' curricula. You are in a fortunate position because you will always be in surroundings largely dominated by religious and cultural atmospheres. This will prevent you from developing the purely utilitarian type of mind which the applied science may tend to make you. But it may be that your success in applied science may create so much wealth that it may blind you to the study of humanities. This you will have to take special steps to prevent.

I have no doubt that the kindly and humane spirit of Hazrat Khalifatul Masih will long guide you and that this Institute will grow into a mighty organisation for the good of humanity. With these few words I have great pleasure in declaring the Fazli-Omar Research Institute open. I wish it God-speed. May it result in the happy blending of science and religion and thus contribute to the forces which are tending to unite us all into One World."

BIAS IN THE USE OF SMALL-SIZE PLOTS IN SAMPLE SURVEYS FOR YIELD

By P. V. SUKHATME, Ph.D., D.Sc. (Lond.)

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SAMPLE surveys for yield of cotton, wheat and paddy, conducted in recent years by the Indian Central Cotton Committee and the Imperial Council of Agricultural Research in the various provinces in India have been carried out on plots of large size, varying from one-tenth to one hundred and sixtieth of an acre.[1,2] The plots are marked with the help of pegs and chains and the produce is harvested with the help of labour specially employed for the purpose. In contrast the plot size used by Hubback in experiments on paddy in Bihar (1923-25), by Mahalanobis in experiments on wheat and gram in Bihar (1943-44) and by workers in England and U.S.A. is very small, of the order of $\frac{1}{4,000}$th of an acre.[3,4,5,6] The plots are marked with the help of a rigid or a semi-rigid sampling frame and the produce is gathered by the experimenter himself without the help of paid labour. In view of this great difference in the methods, an investigation was carried out in the district of Moradabad (U.P.), area 2,283 sq. miles, for comparing different-size plots.

2. Moradabad is divided into six tehsils of which all, except one, have an appreciable area under both irrigated and unirrigated wheat. The plan of sampling consisted in selecting eight random villages from each tehsil, four for experiments on irrigated wheat and four for experiments on unirrigated wheat, except in one tehsil, where all the eight villages were selected for experiments on unirrigated wheat. Sampling was done separately for irrigated and unirrigated wheat. In each selected village two wheat-growing fields were selected at random and in each selected field eight plots were marked at random: (*a*) two equilateral triangular plots of side 33 feet, subdivided into three strips by means of two lines drawn parallel to the base at distances of 8¼ feet and 16½ feet from the vertex along the sides, (*b*) three circular plots of radius 2 feet each and (*c*) three circular plots of radius 3 feet each. The two triangular plots of side 33 feet were marked with the help of chains and pegs. The circular plots were marked with the help of a specially devised apparatus consisting of a peg, a rotating steel tape and a plumb-line. The investigation was carried out by the staff of the Department of Revenue posted in the district, who ordinarily are required to carry out these experiments in the Province under the existing official orders. The entire work was carried out under the close supervision of the technical staff of the Statistical Section of the Council.

3. Out of a total of 768 plots proposed to be harvested under the scheme, 742 were harvested. The results are shown in the statement attached separately for irrigated and unirrigated wheat. It will be seen that small-size plots give biased estimates, but the magnitude of bias diminishes with increase in the size of plot. The results are consistent both for irrigated and unirrigated wheat. They show that small plots under 30 square feet result in serious over-estimation of yield, but even plots of 118 square feet are not free from bias. The differences in the yield estimates of plots other than those of approximately the same size are found to be statistically significant. The results are found to be similar in all the six tehsils in which experiments were carried out.

4. Yates has previously reported the existence of bias from the use of small-size plots.[7] He compares the results of experiments with a circular hoop of 10 square feet in area with those of sample plots of one-twentieth of an acre in size and the field as a whole, and finds

TABLE I

Average yield in pounds per acre with percentage over-estimation for plots of different sizes

Shape of plot	Size of plot in sq. ft.	Irrigated wheat			Unirrigated wheat		
		No. of plots	Average yield in pounds per acre	Percentage over-estimation	No. of plots	Average yield in pounds per acae	Percentage over-estimation
Equilateral triangle,							
Side 33′	471·55	78	831·1		107	539·0	
Side 16½′	117·89	78	870·6	4·8	107	598·2	11·0
Side 8¼′	29·47	78	961·9	15·7	107	664·9	23·4
Circle,							
Radius 3′	28·29	117	954·5	14·9	163	618·8	14·8
Radius 2′	12·57	117	1183·3	42·4	161	767·7	49·1

a very considerable bias in the use of circular hoops. The bulk of the bias, according to him, is due to the tendency to cast the hoop on the good parts of the crop.

5. In this investigation, the bias seems to be due to the tendency on the part of workers to include border plants inside the plot. The contribution of the border plants to the harvested produce is appreciable when the plot size is small, and is the main cause of the observed bias. The decision to include (or exclude) the border plants inside the sample area is particularly difficult in the case of cereals where the plants consist of several tillers, and necessarily depends on the tendency of the workers. With increase in the size of the plot, the contribution of the border plants decrease to have any appreciable influence on the estimates of yield.

6. An appropriate test of bias would have been to compare the results of different sizes of plots with those obtained from harvesting the whole field. It was not, however, found feasible to harvest the whole field in this investigation. A separate investigation was, therefore, conducted in Madras for comparing the results of large plot size (one-twentieth of an acre) with those derived from harvesting the whole field. The average estimated yields from the plot and from the field as a whole came to 1,477 and 1,447 lbs., respectively as against the standard error of 153 lbs. of the difference between the two and show that large plots are free from border bias.

7. The results of the investigation show that in the unevenly sown crops in India and possibly also in U.S.A. and England, the use of small-size plots such as are marked by rigid or semi-rigid sampling frames and whose produce can be collected by the experimenter himself without the use of paid labour, particularly in the hands of the departmental staff who usually conduct these experiments, cannot be relied upon to furnish correct results. They provide a clear evidence against the adoption of small size plots under the present Indian conditions, particularly those in the temporarily settled parts of India, owing to the very serious risk of bias involved in their use. The considerations of practical convenience and economy advanced in their favour must be considered as all secondary before the question of bias. Even assuming that the difficulty of bias can be got over by evolving precise scientific tools, the results indicate that the use of small-size plots involves a very considerable increase in sampling in order that the yield may be estimated with precision on par with that attained through the use of the existing large-size plot and is unlikely to be economical under Indian conditions, until at any rate such time as facilities for transportation and travel from one village to another change to what they are in England and U.S.A.

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MILK MARKETING IN INDIA

SUPPLY of inexpensive and adequate quantities of liquid milk is the primary duty of a nation's dairy industry. That in the existing conditions both these requirements are not fulfilled is a painful fact. This subject has been receiving wide publicity during the last ten years but as judged from the standpoint of the needy consumer the position has deteriorated.

This matter has also received the attention of the Government from time to time and it is earnestly to be hoped that something tangible will result from this planning, in the very near future. The latest survey about the Dairy Industry of India has been carried out by Mr. R. A. Pepperall of the Milk Marketing

Board, England.* Mr. Pepperall has investigated afresh the problem of marketing fluid milk; as stated in the introduction, he has tried to avoid contact with previous surveys and data so as not to prejudice his conclusions.

The following are some of the main points gathered by Mr. Pepperall during his suvey. Allowing for the difference in population, India maintains about eight times as many milch cattle as are required for the milk supply of England and Wales. Dairy industry lacks any organisation for which the authorities and the public should share equal blame. India must learn to manage better her stock of indigenous cattle. Government breeding and dairy farms should make available to the people at large, bulls with reliable records and not dispose them of in a half-hazard manner. For better breeding artificial insemination should be organised on a wider scale.

The possibilities of using certain marine plants and dried fish to milch cattle may repay investigation. Cultivation of berseem should be encouraged. Oilseeds and cakes produced in this country should be conserved and used for feeding to cattle and increasing the fertility of the soil rather than sold for export. The problem of disposing off a large surplus of our half-starved stock which cannot be supported should be squarely faced. Milch animals should be mated in proper season rather than carry on till the animal becomes dry when its maintenance becomes increasingly uneconomical. Weaning of young stock is possible and should be encouraged.

Rapid surveys are necessary to assess the cost of production of milk in different parts of the country. To ensure a steady supply of milk the producer must be guaranteed a satisfactory price. Measures should also be found for granting loans for purchasing feeds, etc., thus saving him from the ruinous money-lender.

The hygienic quality of milk is very poor and the authorities concerned should pay greater attention to this question. This will include adequate supervision and education right from the care of animals to the final disposal of fluid milk to the consumers.

All efforts should be made to abolish the present system of maintaining cattle stalls in our cities. For ensuring a sufficient supply of milk to urban areas, regions of supply which are distant from towns and cities and which have water and grazing facilities should be developed. Special rail service, for the transport of milk is an absolute necessity. Premises where milk is produced and processed should be strictly supervised so as to avoid some of the present undesirable features. That these things are possible under Indian conditions is amply demonstrated by the system of milk production and processing followed at the various military dairy farms.

To cheapen the present cost of milk, use of standardised milk (4·0 per cent fat) has been suggested. This will make the same quantity of milk go much further and also give extra fat which can be utilised for butter or ghee manufacture.

Mr. Pepperall rightly suggests that the dairy industry should not look up to the Government to do everything but cultivate an independent outlook and become self-supporting. To reorganise the dairy industry, creation of Milk Commissions has been suggested, which should be independent of direct Government control. The duties of such a Commission will be to stimulate milk production and improve the quality of milk; organise co-operative societies; provide loans to farmers, encourage systematic breeding; arrange for the removal of animals from city areas and develop new promising areas; investigate into the cost of milk production and distribution; supervise the disposal of surplus milk; prepare and sell standardised milk; issue the requisite licences to producers, distributors and manufacturers; dispose off unthrifty animals; reorganise the supply and distribution of milk in cities; and in short, control all the activities pertaining to the dairy industry with the mutual consent and co-operation of all the interested parties.

The above recommendations are not new to our readers and the best suggestion that we can now offer is for early action. In the beginning the Government will have to take some initiative but later on these activities may be left entirely in the hands of milk commissions of the type suggested. The problem is so big that we do not expect that everything will fit in with the paper plans but without such failures no progress will ever be made. In the beginning we must concentrate our energy and resources on the production and distribution of liquid milk. Unless plenty of cheap and clean milk can be assured for our growing population it may not be desirable to build factories for the manufacture of Western types of milk products like dried and evaporated milks. Till our liquid-milk market is organised on a firmer basis these products can easily be imported from areas where they are economically produced. Any reorganisation of dairy industry brings in the question of transport. So far, this has been and still remains the bottle-neck. With all the railways under Government control there should be no difficulty in extending all the facilities required by the dairy industry. Along with our railroads, a proper milk supply should be accounted as the life-line of the nation.

In the modern world no problem can be solved without research. The prime importance for our dairy industry is to solve the liquid-milk problem of the nation and for the time being at least all our research activities should primarily be directed to this end. This work will include gathering accurate knowledge about the composition of milk, methods for assessing the quality of milk, increasing the life of milk and developing new methods for storage and transport which are best-suited to the climatic conditions of this country.

Note.—The cost of printing this article has been met from a generous grant-in-aid from the Imperial Council of Agricultual Research, New Delhi.

* "The Dairy Industry of India,"—Report on and investigation with recommendation, 1945, published by the Department of Education, Health and Lands, (now Dept. of Agriculture), Govt. of India, New Delhi."

LETTERS TO THE EDITOR

ULTRAVIOLET BANDS OF ZINC IODIDE

ANALYSING the emission bands of HgF into two systems, Howell[1] has shown them to be due to $^2\pi - ^2\Sigma$ transition between Hg atom-like levels, the doublet separation being related to ^3P width of the Hg atom. This view was confirmed by one of the authors[2] from the band systems of HgCl and HgI.

Howell also indicated that a probable similarity in electronic transition should be found in the band spectra of the halides of zinc. But only among ZnF[3] and ZnCl[4] bands was a doublet separation of 379 cm.$^{-1}$ and 383·5 cm.$^{-1}$ respectively detected with certainty, approximately equal to the corresponding atomic coupling constant 386 cm.$^{-1}$

In the light of this, the authors have investigated the ZnI bands. Two systems are found in the appropriate region. One of these was established previously by Wieland.[5] The second is newly found consisting of 10 bands (Wieland has mentioned three of these). They are seen as diffuse pairs between λ 3280 and λ 3170, and could be arranged into two v' progressions with $v'' = 0$ and I. The (0,0) band is suggested at ν 30499·5, the interval between which and the (0,0) band (ν 30129·5) of the first system being 370 cm.$^{-1}$ It agrees closely with the predicted value for the zinc halides.

A full discussion will be published shortly.

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Guntur,
March 15, 1946.

1. Howell, *P.R.S.* (Lond.), 1943, **182**, 95. 2. Rao and Ramachandra Rao, *Curr. Sci.*, **1944**, **13**, 279. Rao. Sastry and Krishnamurty, *Ind. Jour Phy.*, 1944, **18**, 323. 3. Rochester and Olsson, *Zeit. f. Phys.*, 1939, **114**, 495. 4. Cornell, *Phy. Rev.*, 1938, **54**, 341. 5. Wieland, *Helv. Acta. Phys.* 1929, **2**, 42.

IDENTIFICATION OF TIMBER WOODS BY THE METHOD OF LIGHT-SCATTERING

IN a previous note in this *Journal*,[1] the authors have reported the results of depolarisation measurements of the transversely-scattered light in aqueous timber wood extracts. It was shown therein that, under identical conditions of extraction, the factors of depolarisation of the scattered light were unique for each extract. The reproducibility of the reported results is, however, governed by the various conditions of experiment, viz., the weight of the shavings of the timber wood, the volume of the water used and the period and manner of supply of heat for preparing the extracts. These factors cease to be significant only when the extracts are saturated. The authors have, therefore, carried out depolarisation measurements in saturated timber wood extracts with a few organic liquids.

The timber woods used in the present work are: (1) *Pink cedar* (*Acrocarpus fraxinifolius*; (2) White cedar (*Chikrassia tabularis*); (3) Jack wood (*Artocarpus integrifolia*); (4) Teak wood (*Tectona grandis*); and (5) Rose wood (*Dalbergia latifolia*). Fine shavings of these specimens were obtained by planing and were thoroughly dried by keeping them in a desiccator for two days. The extracts were prepared from the dried shavings with the help of the Soxhlet apparatus. A period of 4-6 hours of continuous extraction was found to be quite adequate for the resulting solutions to become completely saturated. The procedure adopted for rendering the extracts mote-free and the experimental arrangements for determining the depolarisation factors ρ_u, ρ_v and ρ_h[2] were exactly the same as described in the previous note.

The results obtained with the ether extracts of the above specimens are reproduced in Table I. The tracks of the scattered light in all these extracts were easily comparable, the influence of fluorescence being negligible. In no case was ρ_h found to depart from unity.[3]

TABLE I

Extract	Colour of extract	ρ_v%	ρ_u%	
			Observed	
Pink cedar	very slightly yellowish	6·2	11·1	11·7
White cedar	colourless	33·7	52·0	50·4
Jack wood	slightly yellowish	28·4	46·1	44·3
Teak wood	slightly yellowish	30·7	49·3	47·0
Rose wood	red	56·8	72·9	72·4

It is at once seen from Table I that the values of ρ_u and ρ_v are unique for each specimen, the only experimental condition for their reproducibility being that the extracts should be saturated. These values can, therefore, be relied upon for the identification of the respective timber woods. The unitary value of ρ_h denotes that the extracted material, in all these cases, is so dispersed in the ether that the size of the scattering centre is small relative to the wave-length of the light used. This is very much unlike what was found in the case of the aqueous extracts. The optical anisotropy of the scattering elements is lowest in the almost colourless pink cedar extract and maximum in the red-coloured rose wood extract.

Details will be published elsewhere.

The authors' thanks are due to Prof. P. Bhaskara Pannikar, Head of the Chemistry Department, and Prof. R. N. Selvam, Head of the Physics Department, Pachaiyappa's College, Madras, for their helpful interest during the progress of this investigation.

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Madras, V. P. NARAYANAN NAMBIYAR.
April 15, 1946.

1. Venkateswara Rao, D., and Narayanan Nambiyar, V. P., *Curr. Sci.*, 1946, **15**, 19–20. 2. Krishnan, R. S., *Proc. Ind. Acad. Sci.*, 1935, **A, 1**, 915–27. 3. Venkateswara Rao, D., *Ibid.*, 1942, **15**, 24–34.

EMISSION BANDS OF BROMINE

Low pressure bromine vapour obtained by heating cupric bromide and kept in flowing condition, was excited by low power high frequency oscillations of about 700 Kc/sec. The spectrum of the discharge was photographed on E_1, E_2 and medium quartz Hilger spectrographs using superpanchropress P1209 and process regular B 20 Kodak plates. The spectrum exhibits a series of ill-defined diffuse bands which extends from about 4200 to 2200 A and can be conveniently described in two sets. The first set starts with weak bands and ends in two groups of fairly intense bands the maxima of which are at 3549·4 and 3336·6 A respectively. The second set starts with two intense groups of bands maxima of which are at 2900·4 and 2753·6 A respectively, and ends in a number of groups of bands which diminish in intensity towards the shorter wave-lengths.

As in the emission spectrum of iodine, these bands in bromine appear as a series of diffuse and more or less broad bands which are, therefore, be referred to as fluctuation bands. The average width of bands in the first set is of the order of 230 cm.$^{-1}$, three of them at 4224·5, 3549·1, 3336·6A, being however much broader. The bands in the second set are much less broad, the average width being of the order of 130 cm.$^{-1}$, the stronger bands again showing a slightly greater breadth. The data are given in Table I.

The bands are thus apparently similar to those of iodine, but are, however, bodily displaced towards the shorter wave-lengths. An-

TABLE I. *First set of bands*

Group	Int.	λ in air, A.	ν Vac.	Group	Int.	λ in air, A.	ν Vac.
	4	4224·5	23665				
	1	4090·4	24441		10	3549·4	28166
	1	4021·5	24859	II	4	3420·2	29230
I	3	3932·5	25422		6	3366·8	29693
	2	3849·7	25969		10	3336·6	29962
	?	3809·2	26245	III	1	3268·6	30585
	2	3739·7	26733		1	3239·2	30863
	4	3597·8	27787				

Second set of bands

Group	Int.	λ In air, A.	ν Vac.	Group	Int.	λ in air, A.	ν Vac.
	1	2980·9	33537		6	2526·9	39562
	1	2952·0	33865		6	2510·9	39814
	8	2923·8	34192	V	6	2494·2	40081
I	10	2900·4	34468		7	2478·8	40330
	8	2872·5	34803		4	2464·8	40559
	4	2844·2	35149		3	2452·6	40761
	5	2814·3	35522				
					2	2444·4	40897
	7	2780·6	35953	VI	2	2432·3	41101
	8	2753·6	36305		4	2421·1	41291
II	7	2732·4	36587		?	2406·8	41536
	7	2709·8	36892				
	5	2688·7	37182		?	2388·0	41863
					2	2375·0	42092
	4	2654·8	37656		3	2360·8	42346
III	6	2638·9	37883	VII	2	2349·4	42551
	6·2	2623·1	38111		1	2337·9	42760
	?	2608·9	38319		2	2326·3	42979
					2	2313·9	43204
	5	2580·6	38739		1	2304·5	43380
IV	5·2	2564·7	38979				
	2	2549·3	39215		?	2288·0	43693
					?	2261·1	44212
				VIII	?	2234·9	44731
					?	2212·8	45180
					?	2196·6	45511

other striking difference between these and the iodine bands is that while the latter, particularly those towards shorter wave-lengths, occur in clearly marked and definite groups somewhat like sequences, the bromine bands are much less pronounced and more diffuse. Probably this tendency is developed still more in chlorine where only continuous bands are recorded.

I am grateful to Dr. R. K. Asundi for his valuable guidance and to Prof. S. P. Prasad and Prof. D. K. Bhattacharya, Science College, Patna, for permission to use E, and E, quartz spectrographs.

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March 19, 1946.

1. Asundi and Venkateswarlu, *Nature*, 1945, **156**, 452. Curtis and Evans, *Proc. Royal Soc.*, 1933, **141 A**, 603. 2. Singh and Adiga, *Science and Cult.*, 1944-45, **10**, 95.

CONSERVATION OF THE MINERAL WEALTH OF INDIA

THIS is an age of minerals, but they are vanishing assets. Their efficient use is, therefore, a matter of vital national concern and greatest attempts are, therefore, being made in every country to affect as much conservation as possible by eliminating all possible wastage to prolong the life of the deposits. With this object in view the authorities concerned have turned their attention to the mica deposits of India. The writer believes it to be the aim of everybody concerned to bring to the notice of the public, wherever any avoidable wastage of mineral wealth may be occurring. He has noticed some glaring examples, some of which are mentioned below.

In quarrying limestone near Katni in the Jubbalpore district, a great overburden of clay, about 40 feet in depth, has to be removed. This clay is mainly whitish with reddish,

brownish, yellowish and greenish streaks in places. This clay is already being used in the Katni Pottery Works. But what was noticed in Bajan and Co.'s quarry and in fact in many other quarries, was that good clay along with the overlaying dark-coloured soil was being dumped in the adjoining fields. Evidently, the clay on being mixed with the dark-coloured soil and so dumped is rendered impure. The overburden being huge, thus very large quantities of the clay are wasted. In places hillocks of this material are to be seen, which, as a result of erosion by heavy rainfall during the monsoon season show deep ravines on their sides. First the clay is rendered impure and secondly it is allowed to be washed away freely by rain, when it could be put to good and profitable use.

In the neighbourhood of Katni it was also found that good iron ore was being used as road metal and literally numerous stacks of this mineral were still lying alongside some of the roads. It is a good, hard brownish-black limonite with about 59 per cent. of iron. Its specific gravity was determined to be 3·60. It may be noted that limonite deposits in Lorraine and Luxemburg constitute the most important iron ore deposits of Europe. It is also mined in Sweden, the Harz Mountains, etc. Besides, being an ore of iron, it is also used as a yellow mineral pigment. But in the neighbourhood of Katni its use as a road metal is indeed surprising and that too when unlimited resources of road metal from the Vindhyan sandstone and limestone occur in the same area.

The writer was informed by Mr. Govind Prasad Sharma of Katni that barytes of good quality has been used as ballast on the railway line near Rupaunda railway station, while again unlimited quantities of the Vindhyan rocks are available for the purpose only a short distance away.

Barytes, which is sold to the paint works of the New Industries Ltd., Katni, was observed to contain very good fluorspar, violet in colour, but it was sold with the barytes making it an off-colour second quality. Fluorspar is a mineral in demand in India by the Steel and Aluminium Works. It also finds a number of other important uses. It certainly deserves to have been separated thus raising the price of the barytes and the fluorspar.

Fireclay is being quarried a little more than half a mile north-west of Bhaganwara, which is about 5½ miles north-west of Sleemnabad Road railway station on the Katni-Jubbulpore line. The method of working this deposit is that a pit is dug for extracting the clay. It is remarkable that there is absolutely no percolation of water in the pit, even when it is deep. With the advent of rains, the work is stopped and the deep pit naturally gets filled with water. Next year the old pit remains abandoned and a new site is chosen. This process is repeated and to-day several deep pits and tortuous channels filled with water are to be seen. This procedure tends to spoil the deposit and is certainly not conducive to the conservation of the important deposit of fireclay, a material greatly in demand for manufacturing refractories. It would be indeed unfair and unprofitable to future working as all the water will have to be baled first and then work will have to be carried out in deeper portions. With regard to the depth of the deposit, a deep pit to a depth of 80 feet was put down and it had not touched the base of the clay deposit. The systematic procedure to work this deposit would be to work from one end and to win all the clay to the base of the deposit.

In conclusion, it may be observed that these are only a few of many like cases, and these have been placed before the public in order to make us more conservation-minded with regard to our mineral deposits as once a mineral is lost, it cannot be replaced.

Soil is another mineral resource, the extremely rapid erosion of which deserves to be checked. Dr. Twenhoefel has described it as the most valuable mineral resource. This subject is of course too lengthy for this communication and it is gratifying to note that it is already receiving at least some attention. Our utmost attempt should be to ensure the greatest longevity of the mineral deposits. It is only thus that we can save and ameliorate the condition of human life in this country.

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January 30, 1946.

HEAT OF REACTION, FREE ENERGY OF REACTION AND ENTROPY CHANGE IN BUTADIENE 1-3 FORMATION FROM BUTENE-1

GHOSH and Roy[1] have applied the general specific heat equation $\Delta C_p = 6{\cdot}86 - 0{\cdot}0046\,T + 0{\cdot}000{,}0006\,T^2$ for all dehydrogenation processes involved in the formation of olefines from paraffins and diolefines from olefines of the *n*-butane and isopentane series, since accurate values for the specific heat of only *n*-butane, butene-1 and hydrogen were then available.

Two sets of reliable values are now available for the specific heat of gaseous butadiene-1, 3. Templeton, Davies and Felsing[2] claim less than one per cent. error in their values and propose the equation $C_p = 3{\cdot}32 + 0{\cdot}0516\,T$ (the second term has been put as 0·516 T due to a printing error in their paper) for the specific heat of butadiene-1, 3. Scott and Mellors[3] claim less than 0·5 per cent. error in their values which give $C_p = 2{\cdot}27 + 0{\cdot}0566\,T$ as the empirical equation for the specific heat of butadiene-1, 3. The data of Templeton, Davies and Felsing[2] are systematically lower than those obtained by Scott and Mellors[3] the maximum difference amounting to 3 per cent., which is larger than can be expected from a consideration of the expected errors.

On the basis of these values for the specific heat of butadiene-1, 3 in conjunction with

TABLE I

Reference	Specific heat equation	Equation for standard-free energy of reaction	ΔH°_{298} cals.	ΔF°_{298} cals.	ΔS°_{298} E.U.
1	$\Delta C_p = 6{\cdot}86 - 0{\cdot}0046\ T + 0{\cdot}000{,}0006\ T^2$	$\Delta F_T = 25{,}496 - 6{\cdot}86\ T \ln T + 0{\cdot}0023\ T^2 - 10^{-7}\ T^3 + 20{\cdot}03\ T$	27,342	20,015	24·6
2	$\Delta C_p = 5{\cdot}6 + 0{\cdot}000186\ T + 0{\cdot}000{,}0006 T^2$	$\Delta F_T = 25{,}281 - 5{\cdot}6\ T \ln T - {\cdot}000093\ T^2 - 10^{-7} T^3 + 13{\cdot}76\ T$	26,967	19,761	24·2
3	$\Delta C_p = 4{\cdot}55 + 0{\cdot}0052\ T + 0{\cdot}000{,}0006\ T^2$	$\Delta F_T = 24{,}726 - 4{\cdot}55\ T\ \mathrm{Ln}\ T - 0{\cdot}0026\ T^2 - 10^{-7}\ T^3 + 9{\cdot}42\ T$	26,378	19,512	23·04

other data given in the original paper,[1] the thermodynamic characteristics of the reaction

$$\text{Butene-1} \rightleftarrows \text{Butadiene 1-3} + H_2$$

have been evaluated and compared with the values assigned previously by workers in this laboratory.[1] The results are given in Table I.

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1. Ghosh and Roy, *Curr. Sci.*, 1945, **14**, 156. —, *Proc. Nat. Inst. Sci. (India)*, 1946, **22**, 115. 2. Templeton, Davies with Felsing, *Jour. Amer. Chem. Soc.*, 1944, **66**, 2033. 3. Scott and Mellors, *J. Research NBS.*, 1945, **34**, 243.

PRODUCTION OF HYPOPROTHROMBINAEMIA IN THE RAT BY FEEDING SULPHATHIAZOLE AND ITS CURE WITH SYNTHETIC VITAMIN K

SINCE Dam, Schonheyder and their associates[1,2] conclusively showed that a deficiency of vitamin K in the chick resulted in a hæmorrhagic syndrone characterised by lowered prothrombin level, many attempts have been made to produce the same symptoms in common laboratory animals. These have resulted mostly in the development of methods which depend on some form of surgical procedure which inhibits the absorption of vitamin K and thereby brings about a deficiency of this vitamin in the animal.

The work of Greaves and Schmidth[3] on rats as well as that of Dam, Schonheyder, and Lewis[4] shows, that in general mammals are not very susceptible to a purely dietary deficiency of vitamin K.

The observation that the intestinal bacteria inhabiting the intestines of most mammals are a potent source of vitamin K have recently led to the development of methods for producing vitamin K deficiency in the rat. Daft, Kornberg and their co-workers[5,6] as well as Black *et al.*[7] report that continual feeding of sulphonamide drugs to rats, together with a synthetic ration free from vitamin K can consistently produce hypoprothrombinæmia.

These findings suggest a convenient method for producing vitamin K deficiency in the rat which has potentialities of being developed into a curative method for the assay of this vitamin.

With this object in view, further data are presented, concerning the production of hypoprothrombinæmia in the rat using sulphathiazole in conjunction with a diet free from vitamin K, and its correction with synthetic vitamin K.

Three groups of male albino rats from the Haffkine Institute stock colony, about a month old, and weighing 25 to 40 grams were used. The synthetic ration given to the animals was the same as that used by Kornberg *et al.*[8] with the exception that the vitamin B complex supplement was supplied in the form of dried brewer's yeast.

The first group of animals was kept on the vitamin K-free diet supplemented with sulphathiazole at 1 per cent. level and 100 μg. of synthetic vitamin K per week.

The second group of animals received the same ration as the first group but without the vitamin K supplement.

The third group received the same ration as the other two groups but without supplement of vitamin K or the drug.

Prothrombin estimations were made by a modified micro method of Innes and Davidson[9] in which the prothrombin in the first drop of blood obtained by clipping the tail was determined.

Purified Russel's viper venom was used as the source of thromboplastin. The supplement of vitamin K was given orally once a week.

It was found that in the first two weeks the animals appeared quite healthy. During the third week the animals of the second group showed an abrupt change in their general condition. They seemed very weak and extremely pale (as seen from the eyes and ears), while some showed bleeding from the ears and nose.

Prothrombin determinations made at this juncture showed that in the majority of animals in this group, a severe prothrombin deficiency had developed, whilst the prothrombin level of the other two groups remained normal. These results indicate that inclusion of vitamin K could prevent the hypoprothrombinæmia produced by the drug. They also showed that a pure dietary deficiency could not be produc-

ed very easily in the rat. The animals of group 3 were kept on the same diet deficient in vitamin K for two and half months, but even then there was no deficiency of this vitamin produced as judged by the prothrombin level. At the end of this period the animals were killed and on dissection they appeared to be normal.

With a view to study whether the administration of vitamin K could cure the severe hypoprothrombinæmia produced in the second group of animals, 100 *µg.* of vitamin K were given by mouth to the animals of this group when they developed a severe deficiency of prothrombin, and the prothrombin time was determined at the end of 48 hours. It was seen that in the majority of cases the prothrombin returned to the normal value during this period. Those animals that did not receive vitamin K did not survive more than a month.

Some of the results illustrating the above observations are given in the following tables:

TABLE I. *Group ii*

Animals of this group received vitamin K-free diet containing 1 per cent. sulphathiazole.

No. of rat	No. of days on diet	Prothrombin time	No. of days after receiving 100*µg.* of vitamink	Prothrombin time after receiving supplement
14	18 days	45 seconds	2 days	12 seconds
21	21 ,,	100 ,,	2 ,,	13 ,,
28	18 ,,	90 ,,	2 ,,	15 ,,
29	18 ,,	80 ,,	2 ,,	15 ,,

TABLE II. *Group i*

Animals of this group received vitamin K-free diet containing 1 per cent. sulphathiazole and 100 *µg.* vitamin K per week.

No. of rat	No. of days on diet	Prothrombin time	No. of days on diet	Prothrombin time	No. of days on diet	Prothrombin time
7	16 days	17 sec.	44 days	15 sec.	60 days	15 sec.
9	24 ,,	16 ,,	44 ,,	17 ,,	72 ,,	18 ,,
10	19 ,,	18 ,,	44 ,,	15 ,,	62 ,,	18 ,,
12	19 ,,	17 ,,	38 ,,	20 ,,	67 ,,	18 ,,

TABLE III. *Group ii*

Animals of this group received vitamin K-free diet.

No. of rat	No. of days on diet	Prothrombin time	No. of days on diet	Prothrombin time	No. of days on diet	Prothrombin time
1	26 days	18 sec.	47 days	18 sec.	60 days	17 sec.
2	24 ,,	17 ,,	47 ,,	18 ,,	60 ,,	15 ,,
3	24 ,,	16 ,,	47 ,,	15 ,,	60 ,,	17 ,,
4	24 ,,	16 ,,	47 ,,	18 ,,	60 ,,	18 ,,

Experiments are now in progress to determine the minimum dose of vitamin K required to bring back to normal the prothrombin time of animals made deficient by the above method.

In order to study the effect of continued feeding of the drug on the liver, some animals were made deficient as described above and sacrificed when a severe hypoprothrombinæmia developed. On dissection, it was found that in the majority of cases, the liver was enlarged and pale. Hæmorrhages were found in various parts of the body, the most common sites being the subcutaneous tissues, the urinary bladder, the epididymis, testicles and the pelvic region. Histological examination of the livers showed fatty infiltration and, in some cases, necrosis of the parenchyma.

A detailed account of these investigations will be published elsewhere.

We wish to thank Sir Sahib Singh Sokhey for his kind interest and encouragement in this work.

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1. Schonheyder, *Biochem. J.*, 1936, **30**, 890–96. 2. Dam, Schonheyder and Tage Hansen, *Ibid.*, 1936, **30**, 1075–79. 3. Greaves and Schmidth, *Proc. Soc. Exper. Biol. Med.*, 1937, **37**, 43. 4. Dam, Schonheyder and Lewis, *Biochem. J.*, 1937, **31**, 22. 5. Daft, Ashburn and Sebrell, *Science*, 1942, **98**, 321–22. 6. Kornberg, Daft and Sebrell, *J. Biol. Chem.*, 1944, **155**, 193–99. 7. Black, Overman, Elvehjem and Link, *Ibid.*, 1942, **145**, 137–43. 8. Kornberg, Daft and Sebrell, *Pub. Health. Rep.*, 1944, **59**, 832–43. 9. Innes and Davidson, *Brit. Med. J.*, 1941, **1**, 621.

OCCURRENCE OF KANUGIN IN THE STEM BARK OF *PONGAMIA GLABRA*

THE root and bark of *Pongamia glabra* are stated to find several uses in Indian medicine.[1] Examination of the root some time back[2] revealed the existence of a crystalline component

which has been designated kanugin. The constitution of kanugin has recently been established[3] as 3 : 7 : 3′-trimethoxy-4′ : 5′-methylenedioxy-flavone and this has been confirmed by synthesis.[4] A study has now been made of the stem bark with a view to isolate any crystalline compounds present therein.

The coarsely powdered air-dried stem bark was repeatedly extracted with hot ligroin. The combined extracts were concentrated first by distillation to recover the solvent and subsequently by heating on a water-bath in an open evaporating basin. The residue was taken up in a slight excess of hot alcohol and treated with water little by little till all waxy and resinous matter separated out. After filtration the aqueous alcoholic solution was evaporated almost to dryness and the solid residue recrystallised from dilute alcohol repeatedly whereby a light colourless solid (stout needles and narrow rectangular rods) melting at 200-202° was obtained. It was moderately soluble in organic solvents and insoluble in dilute sodium hydroxide even after boiling for a few minutes. Its alcoholic solution did not give any colour with ferric chloride. Concentrated sulphuric acid dissolved it to give a yellow solution with a green fluorescence slowly changing into red; a bluish-violet fluorescence was exhibited even by a dilute alcoholic solution. On reducing an alcoholic solution with magnesium and hydrochloric acid a pink colour was produced indicating that it belongs to the group of flavones, while the formation of a deep emerald green colour on warming with sulphuric acid and gallic acid furnished proof of the presence of one or more methylene-dioxy groups in the molecule. Combustion analysis gave the value 64·3 per cent. for carbon and 4·8 per cent. for hydrogen. The above reactions and the elementary composition suggested that the substance should be identical with kanugin. A mixed melting point determination confirmed the identity.

Thus kanugin occurs in both the root and stem of *P. glabra*. Occurrence of the same compounds in different parts of the same plant, particularly in the root and stem, is fairly common; cinchona and liquorice may be quoted as familiar examples. The yield of kanugin, however, is very much lower from the stem bark, being about a tenth of the yield from the root bark. No other crystalline compound could be obtained from the stem bark.

The author's thanks are due to Prof. T. R. Seshadri for his interest in this work.

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February 27, 1946.

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THE pH OF SODIUM BORATE SOLUTIONS—A USEFUL BUFFER MIXTURE

THE determination of the hydrogen-ion concentrations of solutions containing boric acid and sodium hydroxide in which the ratio $Na_2O : B_2O_3$ was varied between 3 : 1 and 1 : 5, was made at 30° C. using the glass electrode. The curves obtained for the different concentrations of the solutions by plotting pH against the ratio $Na_2O : B_2O_3$ brought to light a striking fact that these curves intersect at one point corresponding to a value of Ratio = 1 : 2·425. A solution of sodium borate containing this ratio of $Na_2O : B_2O_3$ is obviously such that its pH remains unaltered when diluted from 0·15 N to 0·005 N. A solid mixture with this ratio of $Na_2O : B_2O_3$ when dissolved in any quantity of water within the range indicated by concentrations used in this work would give a pH = 8·91.

Kiehl and Loucks[1] have measured at 30° C. the pH of $NaBO_2$ and $Na_2B_4O_7$ over a wide range of concentrations. It is interesting to note that these values are in good agreement with those obtained in this investigation. This is brought out in the following table:—

Concentration in Normality	0·05		0·10		0·15	
Solution	K & L	Authors	K & L	Authors	K & L	Authors
$NaBO_2$ *i.e.*, $Na_2O : B_2O_3 = 1 : 2$	10·43	10·38	10·68	10·51	—	—
$Na_2B_4O_7$ *i.e.*, $Na_2O : B_2O_3 = 1 : 2$	9·16	9·13	9·15	9·14	9·18	9·18

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1. *Trans. Electrochem. Soc.*, 1935, **67**, 81.

THE ELECTRICAL CONDUCTIVITY OF AMPHOTERIC OXIDES IN CONCENTRATED SOLUTIONS OF ALKALIS

A DETAILED study of the behaviour of amphoteric oxides towards solutions of alkali hydroxides has been undertaken. During the course of this work the electrical conductivity of solutions of aluminium hydroxide when dissolved in hydroxides of sodium and potassium (between 10 N and 0·5 N) is measured. The results obtained can be represented by the expression $\log \frac{\Lambda_1 - \Lambda_2}{\Lambda_1} = m\sqrt{N} + c$, where m and c are constants, N = normality of the alkali, Λ_1 = equivalent conductivity of the alkali, Λ_2 = equivaleat conductivity of the alkali + aluminium hydroxide. The values of $\sqrt{N}$ for the ratio $\log \frac{\Lambda_1 - \Lambda_2}{\Lambda_1} = 0$ were obtained graphically. At these values, the conditions are such that Λ_2 must become equal to zero. Attempts are made to verify this conclusion

experimentally and when aluminium foil is dissolved in 11N sodium hydroxide, a solution is obtained which has a very high resistance and the equivalent conductivity is about 0·1 mho.

The applicability of the above expression is tested in the case of solutions of zinc hydroxide and the alkali systems by one of us (S. M. M.) with another student (M.B. Kabadi) and it is found to hold good.

Full details of these investigations will be published shortly.

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THE ELECTRICAL CONDUCTIVITY OF CONCENTRATED SOLUTIONS OF SODIUM AND POTASSIUM HYDROXIDE

DURING the course of investigations on the behaviour of amphoteric oxides towards solutions of alkali hydroxides it was found necessary to have values at 30° C. of the electrical conductivities of concentrated solutions of these alkalis. From a search of the literature it was revealed that these values have not been determined and the investigators who have found these values have not done so for the whole range of concentrations at a given temperature. The electrical coductivities of concentrated solutions of sodium and potassium hydroxides were, therefore, determined at 30°± 0·1°. The data obtained are tabulated below:—

N	NaOH			KOH	
	Observed	Bousfield and Lowry	Gmelin	Observed	I. C. T.
10	30·3	30·0	..	60·4	..
8	49·8	49·4	..	84·9	..
7	60·0	60·0	..	98·0	..
6	75·4	75·8	..	117·7	..
5	92·6	91·0	..	135·0	..
4	110·8	111·0	..	158·1	..
3	130·9	132·5	..	179·5	..
2	158·0	160·0	..	205·3	..
1	197·0	196·0	..	232·9	233·0
0·5	214·4	..	214·4	250·0	248·0
0·2	231·0	..	231·0	261·7	262·0
0·1	240·0	..	239·0	268·5	267·0
0·01	250·8	..	251·0	277·3	278·0
1/α	268·0	..	267·0	292·0	293·0

In the above table some of the values experimentally obtained for sodium hydroxide have been compared with those calculated from the results of Bousfield and Lowry[1] and also with those for dilute solutions calculated from the data available at different temperatures in Gmelin.[2] In the case of potassium hydroxide, the values for dilute solutions at 30° C. are available in the International Critical Tables[3] but for those for higher concentrations could not be obtained. It will be observed that the values experimentally determined compare very well with those found and evaluated from the data in the literature.

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1. Bousfield and Lowry, *Phil. Trans.*, A, 1905, **204**, 305. 2. Gmelin, *Handbuch der anorg. Chemie*, 1927, **2**, 229. 3. *International Critical Tables*, **6**, 254.

THE MELTING POINT OF ORTHO-BORIC ACID

THE evidence obtained so far in support of the fact that orthoboric acid combines with many hydroxylic substances to form complex compounds is based on a study of some of the physical properties of aqueous solutions containing boric acid and the hydroxylic substances. But a search of literature revealed that no attempts have been made so far to construct the melting point composition curves of mixtures of ortho-boric acid with other substances. The reason for this is probably to be found in the fact that ortho-boric acid decomposes on heating. According to Merz[1] it is stable up to 70° C. while Lescoeur[2] found the temperature of stability to be 100°C. From the work of Stackelberg, Quatram and Dressel[3] it appears that ortho-boric acid is stable upto 140° C. Whatever the exact temperature upto which ortho-boric acid is stable it is clear that if the melting points of mixtures of boric acid with other substances are below 100° the decomposition of boric acid may be considered absent or negligible while studying the melting point diagram. In trial experiments with mixtures of boric acid with certain hydroxylic substances it was found that the melting points of these mixtures are below 100° C.

With mixtures of ortho-boric acid and glucose, galactose and tartaric acid it was found that the melting point diagrams are of the eutectic type although it is noticed that the two branches of the curves are not straight lines intersecting at the eutectic point. By drawing tangents to the curves parallel to the axis of composition the following data are obtained :—

Substance	Mol. per cent. boric acid	Minimum temp.
Glucose	45·8	51·7°
Galactose	49·3	50·0
Tartaric acid	51·5	62·0

Using the expression given by Kordes[4,5] the melting point of ortho-boric acid was calculat-

ed from the above data. It was found that the calculated values of the melting point of ortho-boric acid were 169·5° C. and 170·5° C. respectively with mixtures containing glucose and galactose. These values are in good agreement with 170° C. given by Stackelberg. Quatram and Dressel[3] which they obtained using an entirely independent and elaborate method. The value obtained with mixtures containing tartaric acid is low being 160·9° C. and this may be due to complex formation. Full details of this investigation will be published shortly as also the melting point diagrams of mixtures of boric acid with mannitol and erythritol.

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ON THE KINETICS OF ENZYME REACTIONS

IN a recent paper[1] it was shown that the substrate molecules may be activated by the enzymes by virtue of some kind of resonance between the enzyme molecules and the substrate molecules. We intend to develop here the idea further and attempt at deducing some well-known laws of enzyme kinetics.

The number of collisions between the enzyme molecules and the substrate molecules will be $= K_1ES$, where

E = Concentration of enzyme
S = Concentration of substrate
K_1 = Constant.

Of this total number of collisions only a small fraction will be able to decompose (some of the primary activated molecules may also be deactivated before reaching the secondary activated state).

Hence, let the concentration of those which decompose be = KES. Now, when in the process of activating the substrate molecules the enzyme molecules have imparted their extra energy to the substrate, they fall into an inactive state from which after a definite but small time interval, they again (by absorbing energy) come to the active state, and can again cause the decomposition of a fresh amount of substrate which will be equal to

$$KE(S - KES) = KES(1 - KE).$$

Similarly, the process will be repeated producing successive decomposition of substrates

$KE\{S - KES - KE(S - KES)\} = KES(1 - KE)^2$

and so on.

Thus, Y, the total decomposition after time t, is given by

$$Y = KES + KES(1 - KE) + KES(1 - KE)^2 + \ldots . n \text{ terms},$$

where n denotes the number of such cycles performed in time t.

Hence,

$$Y = \frac{KES\{1 - (1 - KE)^n\}}{1 - (1 - KE)} = S\{1 - (1 - KE)^n\} = S\{1 - (1 - KE)^{At}\}$$

(since n will be directly proportional to t).

From the above equation it follows:

(i) that during the initial stages of the reaction when t is small,

$$Y = S\{1 - KE\,At)\} = S.K.E.A.t$$

$Y \propto S$ when E and t are constants.
$Y \propto t$ „ S and E „ „
$Y \propto E$ „ S and t „ „

(ii) *Since*

$$Y = S\{1 - (1 - KE)^{At}\}$$

$$\frac{S - Y}{S} = (1 - KE)^{At}$$

$$\text{In}\,\frac{S - Y}{S} = -At \cdot \text{In}\,(1 - KE)$$

$$= KE \cdot At$$

(since KE is small)

$$= K't.$$

This is the well-known monomolecular law for the enzyme reactions. It is evident from the deductions that deviations from the unimolecular law may very well be expected in cases where the enzyme concentration is high or when KE is not small compared to unity (*cf.* Straus and Goldstein[2]).

Biochemical Laboratory,
Bose Research Institute,
Calcutta, A. K. RAI CHAUDHURY.
April 17, 1946.

1, Rai Chaudhury, *Curr. Sci.*, 1945. **14**, 261. 2. Straus and Goldstein *J. Gen. Physiol.*, 1942-3, **26**, 539.

ON THE ESTIMATION OF METHIONINE BY COLORIMETRIC PROCEDURE

THE methods generally followed are idometric, gravimetric and colorimetric. The latter are usually preferred as they are quick and accurate. It is claimed that McCarthy and Sullivan's[1] method is specific for this amino acid and as such was adopted in this laboratory for the estimation of its contents in various pure strains of cereals and pulses grown in the Presidency. During the course of this work it was found that the large amount of carbohydrate in the vegetable foodstuffs interfered with the development of the color. And it was almost impossible to match the unknown with the standard solutions of methionine by visual colorimeter. Various attempts were made to eliminate the source of difficulty and with the technique of trial and error the following procedure was adopted.

(*a*) *Compensating for the interference by carbohydrates.*—Owing to yellow tinge which developed on the addition of reagents and which is primarily due to the breakdown products of carbohydrates during hydrolysis was compensated by adding a calculated amount of hydrolysed starch (amylum) to the standard solution before the addition of the reagent. This procedure developed colours in both standard and unknown which could be easily matched.

(*b*) *Substituting phosphoric acid* (85%) *for*

the H_3PO_4-HCl buffer.—Probably due to more rapid change of pH by H_3PO_4-HCl mixture the final color sometimes was dirty brown or dark green. It was difficult to match with the standard. This difficulty was obviated by using H_3PO_4 in place of the buffer mixture. The acid did not give rise to dirty green tinge or any other color interference even when an excess was added.

(c) *Introducing known amount of methionine into the unknown sample.*—Preliminary experiments have shown that quantities of methionine less than 1 mg. per 15 c.c. gave faint color which could not be matched. The vegetable foodstuffs are usually poor in methionine, hence this difficulty was invariably encountered. Addition of known amount of methionine to the unknown removed this difficulty without affecting the final results.

The procedure in short is as follows:—

5 gm. of cereals were hydrolysed by 20 per cent. HCl in an oil-bath maintained at 125° C. for 6 to 8 hours. The solution was made 100 c.c. volume and filtered. 5 c.c. aliquot was taken in a wide pyrex test-tube 2 c.c. of standard methionine containing 1 mg. was then added. The solution was made strongly alkaline and 1 ml. of 1 per cent. glycine 0·3 ml. of 10 per cent. sodium nitro-prusside (freshly prepared) were added. Second tube containing 2 c.c. standard methionine and 5 c.c. of amylum hydrolysate was similarly treated. The tubes were placed in a water-bath at 35-40° C. for ten minutes and were cooled in ice water for further ten minutes. Phosphoric acid was added drop by drop and with vigorous shaking after each addition. The end-point of the reaction was marked by effervescence which slowly gave place to specific methionine color. Two or three drops of phosphoric acid were further added. The color developed could be matched on a visual colorimeter. Following table shows some analytical results obtained by this method on cereals and pulses.

TABLE I

Methionine content of some cereals and pulses grown in the Presidency

Cereal	Botanical Name	Protein per cent.	Methionine
1. Ragi (B_{11})	*Eleusine coracana*	4·73	0·28
2. ,, (E_{21})	,,	5·05	0·26
3. Ragi (A_{16})	,,	4·67	0·27
4. Wheat(Bansi)	*Triticum vulgare*	10·47	0·28
5. ,, (Motiya)	,,	9·60	0·16
6. ,, (Niphad)	,,	10·41	0·17
7. ,, (Gulab)	,,	10·35	0·24
8. ,, (Jaya)	,,	10·43	0·18
9. ,, (Vijaya)	,,	10·65	0·24
10. Gram (local)	*Cicer-arietinum*	16·08	0·13

Nutrition Research Unit, R. G. CHITRE.
Seth G. S. Medical College, A. B. KENI.
Parel, Bombay,
March 28, 1946.

1. McCarthy, T. E., and Sullivan, M., *J. Biol. Chem.*, 1941, **141**, 871.

THE EFFECT OF CONTINUONS APPLICATION OF FARMYARD MANURE ON THE FERTILITY OF A DEEP BLACK COTTON SOIL

WITH a view to study the effect of continuous application of different organic and inorganic fertilisers on the physico-chemical properties of some important soil-types of the Canal Zones of Bombay Deccan, plot experiments of a permanent nature were laid out at the Padegaon Farm of the Sugarcane Research Station[6] in 1933. Advantage was taken of the opportunity to study the effect of continuous application of farm-yard manure on the fertility of a deep black cotton soil at the end of ten years of experimentation, and a short account of these studies is presented in this note.

The soil used in these studies represents the degraded phase of black cotton soils,[1] and is locally known as "Chopan". The chopan soils are characterised by their alkaline reaction, a zone of accumulation of soluble salts, and the high sodium saturation of their colloidal complex, all of which render them quite unfit for irrigated crops. Since a large portion of the area commanded by the Deccan Canals is covered by the chopan soils their reclamation forms an important item in the Agriculture of the Canal tracts of the Bombay Province. Amongst the soil ammendments commonly used for reclaiming these alkali soils, farmyard manure alone and in combination with gypsum and sulphur has given promising results.[2] Since in addition to its corrective action the application of the manure is likely to influence the fertility of the soil, it was thought desirable to analyse the different layers of the soil, upto a depth of three feet, at the end of ten years of experimentation and the results of these analyses are summarised in Table I.

It will be seen from the table that as an effect of the application of the manure the soil has gained considerably in all the fertilising elements over both the controls. The extent of enrichment of the soil with different constituents calculated in pounds per acre-foot of the soil over the dry control is much higher than that over the irrigated control, thus bringing out the beneficial effect of irrigation in enhancing the fertility of the soil. Amongst the different fertility factors, it is only the nitrogen status of the soil that is improved to a great extent, the descending order of improvement being:—

Nitrogen > Carbon > Total P_2O_5 > Total K_2O.

It would be of interest to note that although the total potash and phosphate contents of the soil have not improved much, the availability of these two important manurial constituents is raised to a very great extent by the application of farm-yard manure. On the basis of the theoretical quantities of manurial constituents which ought to be present in the soil at the end of ten years the total phosphate of the soil has suffered the maximum loss, and it is followed by nitrogen and potash respectively in descending order. The depth-distribution of different constituents shows that the

TABLE I

Extent of enrichment of the soil (upto a depth of three feet) with different fertility constituents

Constituent	Icrease over irrigated control	Increase over dry control	Losses over irrigated control plus subsequent addition
	pounds per acre foot		
Nitrogen	2490 (42·02)	2745 (46·84)	— 510 (7·93)
Carbon	29555 (25·04)	35,220 (29·84)	—
Total P_2O_5	1590 (22·69)	1950 (27·84)	— 1415 (16·75)
Total K_2O	1965 (5 ·93)	9760 (29·45)	— 2535 (7·11)
Available P_2O_5	678·65 (54·17)	722·7 (57·68)	—
Available K_2O	4740·5 (67·40)	5375·45 (76· 5)	—

N.B.- Bracketed figures indicate percentage gains over the co ntrols a id lo sses on the theoretical quantities.

effect of the application of the manure is confined to the surface 12"-13" of the soil.

Chemical Laboratory, J. K. BASU.
Agricultural College, M. M. KIBE.
Poona,
March 16, 1946.

* This scheme was partly subsidised by the Imperial Council of Agricultural Research.

1. Basu, J. K., and Tagare, V. D., *Ind. Jr. Agri. Sci.*, 1943, **31**, II, 157–81. 2. —, *Agri. Coll. Mag.*, Feb. 1943, **34**, No. 4, 1–4.

A NOTE ON THE REACTION BETWEEN SODIUM CITRATE AND IODINE

ALTHOUGH the reactions of organic acids with halogens have been investigated by many workers, the data on the photocatalytic effect of metallic ions on these reactions available in the literature is scanty. As a preliminary examination of the reaction between sodium citrate and iodine revealed certain interesting features, it was decided to undertake a detailed study of this reaction under varying conditions. Our investigations show that this reaction takes place very slowly in the dark at room temperature (30° C.) leading to a perceptible consumption of iodine only after about 17 hours. An increase in temperature accelerates the reaction to a considerable extent but the speed still remains comparatively a slow one at 40°C. There is no perceptible increase in the speed of the reaction in the light of the tungsten filament lamp. The effect of sun light is also not appreciable. These conclusions are in general agreement with those of Srivastava,[1] except with regard to the influence of temperature, but are in contradiction to the observations of Dhar and co-workers[2,3] according to whom this reaction proceeds with quite a measurable speed even at 23° C. An interesting feature of this reaction is that a small fraction of the amount of iodine is consumed immediately on mixing the solutions of sodium citrate and iodine and thereafter the reaction proceeds very slowly. This indicates that we are dealing here with a complex reaction consisting of two or more reactions one of which takes place rapidly on mixing the solutions.

A quantitative study of the reaction reveals that it does not follow any definite order although towards the later stages it tends to follow the zero-molecular law.

The presence of metallic ions such as Mn^{++} and Cr^{+++} is found to accelerate the reaction both in the dark as well as in light, the acceleration due to manganese being much greater than that due to chromium particularly in the dark. It may be mentioned in this connection that Srivastava (*loc. cit.*) failed to notice any effect produced by the presence of Mn^{++} in this reaction in the dark. This failure on his part may be attributed to the existence of what may be called an induction period, which characterises this reaction as mentioned later on. Comparative experiments employing ions in equimolecular concentrations under the same conditions of experiment show that manganese ions are about ten times more effective than the chromium ions in the dark, but in light, particularly with less concentrations of iodine, chromium exhibits a relative increase in its photo-catalytic activity which tends to approach that of the manganese ions. The reaction in presence of Mn^{++} both in the dark as weil as in light is characterised by the appearance of what may be called an induction period in which the reaction velocity is very slow and does not follow any definite order. On the expiry of this period the reaction gathers speed and follows the zero-molecular law. The reaction in the presence of Cr^{+++} exhibits this kind of induction only in light but not in the dark. A rise in temperature. exposure to light and an increase in concentration of manganese ions shorten the duration of induction period. Generally speaking the factors which diminish the induction period accelerate the reaction. The temperature coefficient of the reaction in the dark in the presence of Cr^{+++} and Mn^{++} is very high, the values lying between 6 and 7, whereas the temperature coefficients of the same reaction in light lie between 1·65 and 2·50. The reaction with Mn^{++} in light also exhibits an after-effect inasmuch as the reaction is found to proceed for about 45 minutes after the light is cut off with the same velocity as it did when the light was on.

The final product of the reaction in the dark in the presence of both Mn^{++} and Cr^{+++} is iodoform

In light and in the presence of Mn^{++}, tetra-iodoacetone is formed (*cf.* Srivastava[4]). In the case of Cr^{+++} in light, only a turbidity is produced without the formation of any solid tetra-iodoacetone. Fuller details of this investigation including a discussion on the mechanism of the reaction under different conditions are being published elsewhere.

M. QURESHI.
K. VEERAIAH.

Central Laboratories for
Scientific and Industrial Research,
Hyderabad (Dn.),
April 22, 1946.

1. Srivastava, *Proc. Indian Science Congress*, 1944, **Part III**, *Abstracts*, p. 26. 2. Mukerji and Dhar, *J. Indian Chem. Soc.*, 1925, **2**, 277. 3. Bhattacharyya and Dhar, *Ibid.*, 1929, **6**, 451. 4. Srivastava, *Ibid.*, 1945, **22**, 253.

TAMARIND SEED PECTIN

It has already been reported that the tamarind seed pectin is a carbohydrate yielding xylose, glucose, and galactose on complete hydrolysis.[1,2] Damodaran and Rangachari,[3] on the other hand, claim the presence of arabinose and glucose, and this discrepancy they state as "unimportant differences in the analytical results", and attribute it to the non-homogeneous nature of the preparation.[4] With a view to clarifying the point the tamarind seed pectin has been purified by repeated precipitations (eight times), from dilute aqueous solution, by means of alcohol, and analysed at every stage. After the third precipitation, it becomes sufficiently pure and further purification does not materially alter the analytical data. For instance, the figures for the material obtained after the eighth precipitation do not show any appreciable deviation from those of the thrice-precipitated product, namely, $\alpha_D = 71{\cdot}4°$ and pentosan = 30·5 per cent. At no stage during the analyses of the eight fractions has arabinose been detected, or xylose and galactose missed. It may, however, be pointed out that both nitrogen and phosphorus are not eliminated even in the eighth fraction. It is difficult to say at this stage whether or not they form a part of the molecule.

The presence of xylose has been previously reported on the basis of the formation of the characteristically crystalline osazone melting at 160° and the equally characteristic crystalline cadmium bromide-cadmium xylonate separating in boat-shaped structures.[2] In further support, another characteristic derivative, namely, dibenzylidene dimethyl acetal has now been prepared. When the neutral product of complete hydrolysis is concentrated to a syrupy consistency on a water-bath, dried in a vacuum desiccator for a number of days and afterwards treated with a methyl alcoholic solution of benzaldehyde in the presence of hydrogen chloride, the crystalline derivative melting at 211° gradually separates out. Amongst the ordinary hexoses and pentoses including arabinose, xylose alone gives this derivative.[5]

The findings of Savur and Sreenivasan[6] are in general agreement with ours except the following. In their studies on complete hydrolysis of the pectin by boiling with 3 per cent. sulphuric acid for 8 hours they obtain reducing sugars to an extent of 41·5 per cent., while Damodaran and Rangachari have found 83 per cent. under similar conditions. For the complete hydrolysis we have employed boiling 5 per cent. sulphuric acid for 4 hours, and when calculated on the basis of pure anhydrous pectin, the yield of the reducing sugars (expressed as glucose) amounts to 106·8 per cent. Further, from our studies on specific rotation of the hydrolysate, which varies from 52° to 54°, we have tentatively fixed the ratio of the constituent sugars as 1 : 1 : 1, whereas Sreenivasan and Savur[6] report xylose 2, galactose 1 and glucose 3.

It has been suggested that the pectic substance from the tamarind seeds is a mucilage.[3,4] It may be pointed out that there is not much resemblance between the two substances either in essential chemical composition or in characteristic physical properties; mucilages are not known to form any acid-sugar jellies. Gums, mucilages and pectins cannot be readily distinguished from a study of their chemical composition alone; physical properties go a long way in differentiating one group from the other.

Forest Research Institute,
Dehra Dun, P. S. RAO.
March 9, 1946. S. KRISHNA.

1. Ghose and Krishna, *Curr. Sci.*, 1945, **14**, 299. 2. Ghose, Krishna and Suryaprakasa Rao, *Jour. Sci. & Ind. Res.*, 1946, **5**. 3. Damodaran and Rangachari, *Curr. Sci.*, 1945, **14**, 203. 4. —, *Ibid.*, 1946, **15**, 20. 5. Breddy and Jones, *Journ. Chem. Sci.*, 1945, 738. 6. Savur and Sreenivasan, *Curr. Sci.*, 1946, **15**, 43.

COMMENT ON NOTE ON "TAMARIND SEED PECTIN"

No further work has been done in this Laboratory on tamarind seed "pectin" after the publication of our previous note,[1] as our interest was in genuine pectin. However some of the statements in the present note by Rao and Krishna call for comment. These authors as well as Savur and Srinivasan[2] are of opinion that their observations in regard to the material prepared from tamarind seed are mutually in agreement and differ from our findings. However, the tabulated statement given below of the results obtained in the three laboratories does not in the least bear out this view.

An examination of Table I fails to reveal the alleged similarity in the results of the Dehra Dun and the Bombay investigators. *All* the results are in agreement in showing (i) that the substance gives no calcium pectate according to Carré and Haynes method, (ii) that it yields no galacturonic acid on hydrolysis but a mixture of hexose and pentose and (iii) that the methoxyl and uronic acid values are *low*. This is conclusive proof that tamarind seed contains no pectin inasmuch as pectins are now known to be partially methylated polygalacturonic acids and are estimated quantitatively by determination of the yield of calcium salt of the demethylated polygalacturonic acid.

TABLE I

	Damodaran and Rangachari[1]	Ghose and Krishna[3] Rao and Krishna	Nanji *et al.*[4] Savur and Srinivasan[2]
1. Calcium pectate number	0·0	Not reported	0·0
2. Methoxyl %	1·08	0·0	0·0
3. Uronic acid (%)	12·59	0·0	3·44
Products of acid hydrolysis			
4. Galacturonic acid	Not obtained	Not obtained	Not obtained
5. Yield of reducing sugars (%)	83·0	106·8	41·5
6. Sugars identified	Glucose, Arabinose	Glucose, Galactose Xylose	Glucose Galactose Xylose
7. Relative proportion of sugars	Hexose : Pentose = 53 : 33	Glucose. Galactose: Xylose = 33 : 33: 33	Glucose : Galactose : Xylose = 55: 16: 28

With regard to other analytical details, namely, the percentage of methoxyl and uronic acid, the nature and yield of sugars on hydrolysis, the relative proportions of hexoses and pentoses, etc., there are wide discrepancies between the three sets of results. But, as we have stated before, for establishing the presence or absence of pectin, these discrepancies are of no importance. Furthermore they are unavoidable with the kind of preparations that have been studied. The product examined by us in this Laboratory was obtained according to the original method of Ghose and Krishna.[5] Savur and Srinivasan[2] have analysed a "purified" preparation while Ghose and Krishna[3] and Rao and Krishna have studied a preparation obtained by a modified method. The relation of these purified and modified preparations to the original "pectin" claimed to have been isolated by Ghose and Krishna[5] in 60 per cent. yield is not at all clear There is no doubt that we are dealing with a mixture as is convincingly shown by the divergences in the analytical data. With such a mixture purification or modification of the method of preparation would inevitably lead to fractionation yielding preparations in which all the polysaccharides —and therefore the component sugars—originally present in the crude substance are not necessarily found. Nor is it surprising that Savur and Srinivasan[2] could not find arabinose in a hydrolysate in which over 60 per cent. of the sugars present was destroyed during the process of hydrolysis. In justification of the low yield of sugar obtained by them these authors have quoted the experience of Buston and Chambers.[6] Reference to the paper mentioned shows, however, that Buston and Chambers observed a destruction of sugar amounting only to about 10 per cent. Similarly it will be found on reference to our note[1] on tamarind seed "pectin" that no claim was made as is implied by Savur and Srinivasan and by Ghose and Krishna that identification of the sugars was complete. The ratio of hexose to pentose was determined by quantitative methods quite independent of the identity of the sugars present and was, for our purpose, quite conclusive.

Finally we are at a complete loss to understand the objection of Rao and Krishna to the name mucilage. It is an accepted fact that pectins are mucilages of a special type—take for example, the following sentence from Harrow and Sherwin, *Text-Book of Biochemistry*[7]: "The pectins belong to the vegetable mucileges which are carbohydrate in character and widely distributed in nature." The product obtained from tamarind seed by Ghose and Krishna is an interesting substance because it possesses the useful physical property of pectin of forming sugar acid jellies without the chemical make-up characteristic of pectin. It will be interesting to know the chemical constitution of the jelly-forming constituent of tamarind seed mucilage *after* it has been isolated in a state of proved homogeneity.

M. DAMODARAN.
P. N. RANGACHARI.

University Biochemical
Laboratory, Madras,
April 11, 1946.

1. Damodaran and Rangachari, *Curr. Sci.*, 1945, **14**, 203. 2. Savur and Srinivasan, *Ibid.*, 1946, **15**, 43. 3. Ghose and Krishna, *Ibid.*, 1945, **14**, 299. 4. Nanji *etal.*, *Ibid.*, 1945, **14**, 129. 5. Ghose and Krishna, *Jour. Ind. Chem. Soc., Ind. and News Edn.*, 1942, **5**, 114. 6. Buston and Chambers, *Biochem. Jour.*, 1933, **27**, 1691. 7. Harrow and Sherwin, *Text book of Biochemistry*, W. B. Saunders Co., London, 1935.

TAMARIND SEED PECTIN

WE are in general agreement with the observations reported by Rao and Krishna except in regard to para 3 and we should, therefore, like to bring out the following points :—

Our tentative conclusion[1] that the molecular proportion of the constituent sugars in purified tamarind seed 'pectin' is 2 xylose : 1 galactose : 3 glucose was based on studies in the yields of furfural on distillation with dilute acid and of mucic and saccharic acids on oxidation with nitric acid. This was considered to be the only reliable method for ascertaining the ratios of the sugars. Prolonged acid hydrolysis has been definitely shown to result in a partial destruction of reducing sugars[1] while, in making calculations from studies on specific rotation of the hydrolysate, it frequently happens that small experimental errors are enormously magnified so that the final results, even with mixtures of pure sugars, can be regarded as only very roughly approximate.[2]

These and related observations are discussed

more fully in a paper to be published elsewhere.

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A. SREENIVASAN.

Dept.. of Chemical Technology,
Bombay University,
April 17, 1946.

1. Savur and Sreenivasan, *Curr. Sci.*, 1946, **15**, 43.
2. Browne and Zerban, *Physical and Chemical Methods of Sugar Analysis*, John Wiley and Sons, New York, Third Edition, 1941, p. 986.

AN EFFECTIVE AND INEXPENSIVE METHOD FOR THE CONTROL OF STEM-BORERS IN FRUITTREES, WITH SPECIAL REFERENCE TO *SANTRA* TREES IN C.P. AND BERAR

THIS work was originally started in the year 1941 in connection with the control of the destructive action of *Indrabela quadrinotata* (popularly known amongst the C.P. orchardists as *jaliwala kida*) on *santra* (*Citrus suntara* Engl.) cultivation in the Central Provinces and Berar.

These stem-borers (caterpillars of *Indrabela quadrinotata*) bore holes through the live bark of the tree and come to reside safely in tunnels, often lybarenthine, carved out by them inside the wood. And it is only during night that they emerge from their abode and gnaw the live bark from day to day. The transport of the elaborated food material in consequence is hindered adversely and ultimately the tree succumbs to a slow death within a period of five to six years. Orchards after orchards have thus been wiped off causing considerable economic loss to the cultivator.

A number of treatments (*e.g.*, chloroform, chlorosol, petrol and kerosene oil) commonly recommended by entomologists were given concerted trials. But they did not prove wholly satisfactory and besides, the cost of treatment was prohibitive.

After numerous experimentations and trials since 1941, I have been able to find out a most effective and inexpensive method to control the ravages of this deadly stem-borer on *santra* trees. My method simply consists in introducing hot-water through the external hole or opening leading to the abode of the stem-borer, by means of an ordinary tin-syringe (*pitchkari*) so very commonly used by young folks during the *Holi* festival for throwing or spraying coloured water. Care should be taken to flood the inside of the tunnel fully by a liberal application of hot water. The holes so treated are then plugged the following day with cement or with ordinary clay mixed with cowdung.

This treatment, since its discovery in 1943, has been widely applied with effective success in several *santra* orchards in C.P. and Berar and also in the Bhopal State (C.I.); and the same has been extended with remarkable success to control the ravages of stem-borers in mango, jack, *jamoon*, *ber* and guava. And I dare say that the treatment could universally be employed with success for the control of stem-borers on any tree including even timber.

My grateful thanks are due to Professor T. C. N. Singh for the energetic interest he has taken in giving this method demonstrative trials in several orchards.

Horticultural Research Institute,
Nagpur-Ajni, (MISS) R. SHAH.
March 3, 1946.

TWO VARIETIES OF *TACHARDINA LOBATA*

GREEN'S work on the Coccids of Ceylon gives illustrations of his *Tachardia minuta*. As previously[1] explained his illustrations are the result of a confusion between two distinct species now named *Tachardina lobata*, which is the latest name for *T. minuta* and *Tachardina Silvestrii*, so far not recognised by others. However, *T. Silvestrii* has two symbiotes of which the more predominant one was discovered and illustrated by me.[2] Dr. Walczuch made a cytological study of this insect and found another micro-organism which had escaped my observation. She illustrates both these symbiotes in her thesis.[3]

The organism discovered by me as the symbiote of *T. Silvestrii* was cultivated long ago.[4] At that time the literature was full of yeast like micro-organisms being in symbiosis with insects. Dominated with such ideas the symbiote of *T. Silvestrii* was called a Nocardia, instead of a bacterium, the mycotic genus Nocardia being the nearest approach morphologically to a bacterium.

Tachardina lobata has a symbiote which resembles a species of coccus bacterium. This was also cultivated. At first it was considered a species of yeast and was classed accordingly as an *Atelosaccharomyces* sp. Later it was imagined to be a Torula[2] still under the influence of the special literature on symbiosis. Dr. Walczuch also studied *T. lobata* and illustrates its symbiote giving the same picture as that reproduced by me. But she had kindly shown me some of her slides where the micro-organism appeared different and I imagine Buchner's latest edition[5] of his classical work on Symbiosis has one such illustration by Walczuch. Fig. 1 here gives the symbiote of *T. lobata* as previously illustrated by me, Fig. 1 "M"; which is confirmed by Walczuch, reproduced as Fig. 1 "W". There is no difference between these two typical illustrations. But the picture shown in Fig. 1 "L" is strikingly different and these were the symbiotes that I first saw in some of the slides of Dr. Walczuch. It was discussed but the conclusion was reached that the organism showed polymorphism. This was the natural conclusion when the same insect was supposed to have these symbiotes.

My subsequent work on the isolation of symbiotic micro-organisms had made me sceptical about this hypothetical polymorphism. In 1940 when I went to Bangalore I repeated the entire work. *T. Silvestrii* showed the two micro-organisms; both were cultured and found to be different from each other and thus the work of Walczuch was confirmed.

My illustrations of the symbiote of *T. lobata* were derived from insects growing on *Michelia champaca*. These trees were still found in the estates of the Indian Institute of Science and the shape of the micro-organism was confirmed even when cultivated. The same insect was also found growing on *Pongamia glabra* and gave the identical result. But some trees of *Guazuma tomentosa*, found in the compound of the Chief Secretariat, Bangalore, gave insects whose blood smears had symbiotes shown as Fig. 1 "L". These were also cultured and shown to be different. The symbiotes of *T. Silvestrii* were both bacteria and the symbiotes of *T. lobata* on *Michella champaca* and on *Guazuma tomentosa* were also bacteria and both different from each other.

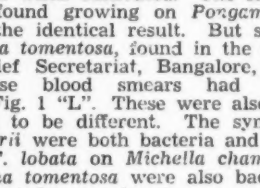


FIG. 1. Symbiotes of *Tachardina lobata*. "M" previously illustrated by Mahdihassan and "W" as confirmed by Walczuch, both M and W belong to the variety *T. Lobata Schmidtii*. The symbiotic picture "L" is given by *T. Lobata var. Walczuchii*.

T. Silvestrii can be distinguished from *T. lobata* in the living condition by a glance. In the dried condition a solution in alcohol of the secretion of *T. Silvestrii* is yellow while the secretion of *T. lobata* is purple, like their colours as illustrated before.[2] The insects now found on *Michelia champaca* and on *Guazuma tomentosa* could not be separated but by their blood smears; from every other point they were identical and both had to be named *T. lobata*. The lac insect of Kashmir, *Lakshadia ficii* has yellow and red forms, so is the case with the Ceylonese insect, *L. albizziæ*. The symbiotes of these yellow and red insects do not show any difference between them. With the varieties of *T. lobata* the symbiotes were different, while their secretion remained the same, both kinds of insects producing the same purple colour.

After some search *Pongamia glabra* was found to have *T. lobata* with round bacterium in its blood smears (Fig. 1 "M" and "W"). Another branch of this tree was infected with brood derived from Guazuma tomentosa. That was done in 1940; when I went to Bangalore in 1941 both these varieties of *T. lobata* were found growing on two different branches of the same tree. The blood smears showed both these insects to be different from each other, leaving no doubt that the food plant had no effect whatsoever. I have previously[1] given a list of trees on which *T. lobata* has been found and this list now needs a revision in the light of what has been said above. It is possible that both the varieties might take to the host-plants mentioned before but experimental inoculation has to be carried out.

But for Dr. Walczuch I should not have known the varieties, hence the variety with symbiotes shown as Fig. 1 "L" is being named *Tachardina lobata Walczuchii* and the former insect, with the symbiotic picture given in Fig. 1 "M" and "W", as *T. lobata Schmidtii*, after Prof. W. J. Schmidt, of Giessen, under whom I also worked on lac and first confirmed the finding of Walczuch. There is no meaning in naming one insect *T. lobata* and the other *T. lobata variety Walczuchii*, for one is as much a variety of the other. Mere museum-specimens cannot but be simply called *T. lobata*, which might mean one or the other variety; cytologically and by blood smears the varieties can be easily distinguished.

Osmania Medical College,
Hyderabad (Dn.), S. MAHDIHASSAN.
April 16, 1946.

1. *Archiv für Naturgeshichte*, 1936, **5**, 1–22. 2. *Archiv für Protistenkunde*, 1928, **63**, 20. 3. *Zeit. für Morph. u. Ökologie*, 1932, **25**, 630. 4. *Some Studies in Biochemistry*—a Dedication to Dr. G. J. Fowler, Bangalore, 1924, p. 187. 5. *Tier und Pflanze in intrazellular Symbiose*, 1930.

THE CHINESE ORIGIN OF THE WORD CHEMISTRY

CHEMISTRY, in German and French, is merely Chemie, while in Arabic it is Alkimia, the word alchemy, the supposed science of converting base metals into gold. There is a Latin and even an earlier Greek form, Kemia, as given by Platts, in his *Dictionary of Urdu, Classical Hindi and English*, 1911, page 890. The enquiry is thus shifted to Greek which probably represents the earliest mention of the word in the above-named languages. But the question is, what does the word Kemia or Chimea connote, be it Greek?

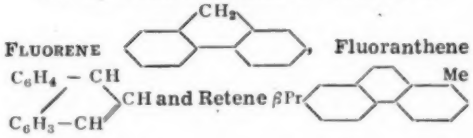
In my other communications, which are to appear in the *Osmania University Research Journal*, I have shown how important it is to apply a synthetic method of giving probable meanings to words, at present signifying nothing, and coining synonyms which would express the sense. Alchemy, or even its purer Arabic form, means the art or science of making gold. I imagine the Greek word does the same. All these names are primarily associated with the idea of gold. The Chinese word for gold is *Chin*, character No. 2032, in the *Chinese Dictionary* of Giles, 1892. It is pronounced as *Kem* in the Cantonese dialect and as *Kim* in the Hakka dialect, also of southern China. *Mi* is character No. 7809; Giles translates it as "to go astray, fascinated, infatuated" and gives the term *Ts'ai-Mi* which he renders as "Mad on making money; avaricuous". This I consider is a paraphrase rather than a translation but has to be respected as the attempt of a savant. Similarly *Chin-Mi* would be translated as "Mad on making gold" in the style of Giles, while a more realistic rendering would signify "Bewitched with the idea of making gold; gone astray in believing that gold can be made." These would be translations where the sense of the original Chinese

text is well preserved, although the English here suffers in quality. The word *Mi*, of the classical Chinese, is also pronounced *Mi* in Hakka, while in Cantonese it is *Mai*. The Cantonese term *Kem-Mai* and the Hakka term *Kim-Mi*, particularly the latter, seem to be the origin of derivatives like Kemia the Greek, Chemie the French, and Alchemy the Arabic word.

The Chinese are shrewd observers. In their term *Kim-Mi* they have expressed exactly what alchemy is. It is not the art or the science of making gold. What can be observed and easily verified is the misplaced enthusiasm of the alchemist, his bewitchment rather than his achievement. There being no science of gold making such a name would be a misnomer, so the Chinese, with their love for realism, have expressed, by their term *Kim-Mi*, the psychology of some people. Bewitchment for gold is not madness for gold, the latter is something like a caricature in words of the former expression; and to make the subtle difference between them gives much credit to the Chinese mind. Madness for gold exaggerates facts and conveys something ridiculous, while bewitchment for gold leads one to a tragic end, which is implicitly expressed in the Chinese name. Of all the terms for alchemy, the Chinese term *Kim-Mi* is the most real expression.

Osmania Medical College,
Hyderabad (Dn.), S. MAHDIHASSAN.
April 20, 1946.

CHEMICAL STRUCTURE IN RELATION TO ACTION ON PLANT NUCLEUS



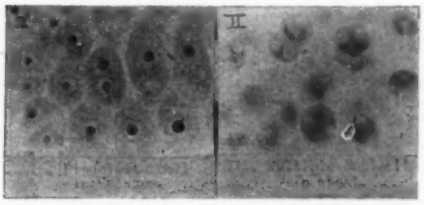
were used to treat seeds with a view to correlate molecular structure and action on plant nucleus. These were made into 5 per cent. solutions in lard and seeds were soaked in these pastes for different periods. Three types of seeds were used: (*a*) *Cajanus indicus* (Spreng) which has a thick seed coat, (*b*) *Triticum vulgare*, pure strain I.P. 165 with a thin seed coat, (*c*) *Cucurbita maxima*, in which the seed coat was artificially removed. The treated seeds were soaked, sprouted, and root tips used for cytological study. Some wheat was grown to maturity. It was found that the treated material could be grown to healthy plants. The germination percentage was almost normal for *Triticum* and *Cajanus seeds* treated for 20 days. Prolonging the treatment reduced germination percentage.

Genetic effects.—The plants from treated wheat seeds closely resembled the control plants except in one feature, namely, in 5 out of 50 plants the pollen grains were larger. The normal pollen diameter was a constant 56 μ at dehiscence stage and in the new type about 60 to 62 μ.

Cytological effects.—Treatment lasting 20 or more days generally produced cytological changes. The most apparent was in the nucleolii, their number being increased as below (Fig. 2).

Plant	Normal	Treated roots
Triticum	1 or 2	2 to 4
Cajanus	1	2
Cucurbita	1	2 to 3

In some *Cajanus* and *Cucurbita* material some binucleate cells were produced, possibly by temporary inhibition of cell wall (Fig. 1).



I. Binucleate cell in *Cajanus*. II. Multiple nucleoli in wheat.

There were other changes in chromosome behaviour and plane of cell division, and these are being analysed. There was no clear evidence of the chromosome number being increased.

There was not much difference between the chemicals in their action, but retene seems to be the most effective. The expectation that the hydrocarbons would pass into the cells in a fatty solvent, and later affect the nucleus appears to be confirmed. It is probable that chemicals more akin to the carcinogenic hydrocarbons, benzpyrene and cholanthrene, and their homologues, would be more potent when applied similarly. We wish to acknowledge the help and encouragement given by Principal V. K. Badami, PH.D. (Cantab.), in connection with this work.

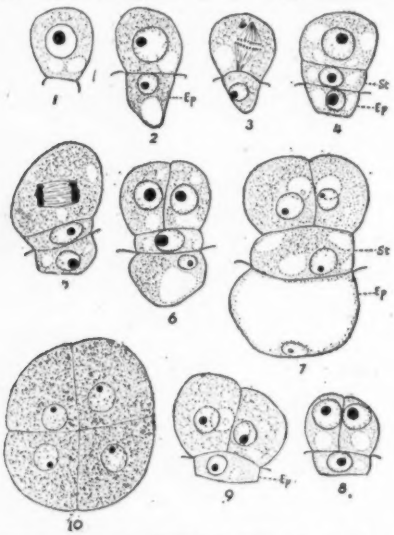
S. SAMPATH.
S. S. RAJAN.
S. P. SINGH.
College of Agricultural Research,
Benares Hindu University,
April 11, 1946.

GLANDULAR TRICHOMES ON THE OVULES OF *LEONURUS SIBIRICUS* LINN.

THE occurrence of glandular trichomes on the various parts of the plant-body is characteristic of Labiates. In some species they occur even on the external surface of the ovules. A developmental study of the trichomes on the ovules of *Leonurus sibiricus* Linn. is presented

here in view of its bearing on the classification of these structures in the family Labiatæ (Schnarf, 1917).

The initiation of a trichome is seen by the bulging of an epidermal cell and is noted before syngamy, the stimulus of fertilisation being responsible for their greater production. The epidermal cell divides transversely to form a basal cell which remains epidermal and an upper cell (Figs. 1-2). The latter again divides transversely to form a stalk cell and the apical primary gland cell which by two vertical divisions gives rise to a typical four-celled glandular structure with a rectangular stalk cell below (Figs. 3-7). The vertical divisions may, however, be initiated on the upper cell resulting from the first division of the epidermal cell, so that sessile gland results (Figs. 8-9). Occasionally oblique divisions have been found to occur.



Leonurus sibiricus L. FIGS. 1-7. Stages in the development of stalked glands (×1600). FIGS. 8-9. Stages in the development of sessile glands. (×1600). FIG. 10. Top view of a mature four-celled gland (×1600). *Ep*=Epidermal cell. *St*=Stalk cell.

As the ovule grows in size both longitudinally as well as laterally, the sides of the glands gradually approximate the adjacent ovarian wall, the result being that the innumerable glands have a compressed appearance. These glandular organs are, however, absent around the micropylar part of the ovule.

Schnarf (1917) distinguished two types of glandular trichomes which occur on the external surface of the ovules, *viz.*, "*Lamium* type" which are sessile, usually consists of four cells and develop after fertilisation, and the "*Scutellaria type*", which are stalked, multicellular and disc-shaped, and develop before fertilisation. The trichomes of *Leonurus sibiricus* resemble the "*Lamium* type" in the sessile and four-celled nature and the "*Scutellaria* type" in having a stalk and developing before fertilisation. Junell (1937) refers the trichomes of *Leonurus cardiaca* to the "*Lamium* type" as they appear after fertilisation and though he anomalously includes the stalked glands of *Physostegia virginiana* in "*Lamium* type" he states again that it can possibly be included in "*Scutellaria* type" as they appear before fertilisation. Thus the rigidity of the use of characters like the presence or absence of a stalk or the appearance before or after fertilisation as employed by Schnarf (1917) cannot be maintained in the light of the present observations in *Leonurus sibiricus* and that of Junell's (1937) in *Physostegia virginiana*. It is better to distinguish them only on the basis of the complexity of structure as 'simple' (1-4-celled) or 'multicellular and disc-like' glands.

My thanks are due to Dr. I. Banerji for the interest taken in the work.

JAYANTA KUMAR GANGULY.

Department of Botany,
Calcutta University,
December 22, 1945.

1. Junell, "Die Samenentwicklung beieiningen Labiaten L.," *Sartryck ur Svensk Botanisk Tidskrift*-1937, **Bd.31**, 67-100. 2. Schnarf, "Beitrage Zur Kenntni, der Samenentwicklung der Labiaten" *Denkschr. Akads Wiss. Wien. Math. Nat. Kl.*, 1917, No. 126.

BIOLOGICAL NOTES ON *PLEUROTROPIS FOVEOLATUS* CRAWFORD—A LARVAL PARASITE OF *EPILACHNA VIGINTIOCTO-PUNCTATA* FAB.

Pleurotropis foveolatus, first described by Crawford (1912) from specimen forwarded by Dr. Coleman of Mysore, and recorded by Ayyar (1921) and Krishnamurti (1932) in South India, was observed in Bihar (1940) while combating *Epilachna Vigintioctopunctata* which is a serious pest on vegetables such as potato, tomato, brinjal and cucurbits. Since the details regarding the biology and life-history of this chalcidoid parasite are not known, the following brief notes are recorded :—

The fourth instar larvæ are parasitised by the female parasite, which punctures the host dorsolaterally for depositing her eggs. The process lasts for 15-20 minutes and each female can handle 8-10 larvæ, before her death. The parasitised larvæ turn brown, become sluggish, scarcely feed and fail to pupate and die in 5-6 days. They are usually observed sticking to the under-surface of the leaf between July and February and to the stem of the plant during March to June. Fifteen to twenty parasites have been recovered from each parasitised larva collcted in the field.

The parasite-egg is smooth, shiny and transparent when fresh; it is spindle-shaped, the narrow half being curved. The period of incubation lasts from 24-28 hours in summer, and 48-72 hours in winter. The parasite larva is white, transparent and curved on hatching and turns yellowish as it feeds on the host. The full-grown larvæ are slightly curved, gently taper towards both ends and remain attached to one another. The larval period ranges between 7-8 days in summer and 14-15 days in winter. Pupation takes place within the host's body the pupal period ranging from 3-4 days in summer and 10-12 days in winter.

The adult parasites emerge out through irregular holes nibbled in the body skin of the host and mate soon afterwards, the process occupying, on the average, about 30 seconds. The average number of eggs laid by a female is 24·8, the maximum being 50. The female may parasitise more than one host and live for 10 days; while the male could live up to 8 days.

Eighteen broods of the parasite were observed in a year under laboratory conditions. The other important host for the parasite is *Epilachna dodecastigma*. The parasite is commonly seen in the field all round the year but from December to January and from March to June it becomes scarce. The population of the parasite as well as its host is reduced due to adverse temperature conditions during these periods.

Krishnamurti (1932) has observed at Bangalore that the percentage of parasitism has never exceeded 5 to 8. The following figures will show that in Bihar the percentage of parasitisation exceeds 10 during 8 months of the year and reaches the maximum of 16·9 in October.

TABLE I

Showing the extent of parasitism in the larvæ of Epilachna Vigintiocto-punctata

Months	Total number of larvæ collected	No. of parasitised larvæ	Percentage of parasitism
July	76	10	13·1
August	238	30	12·6
September	108	13	12·0
October	71	12	16·9
November	112	15	13·3
December	78	8	10·2
January	59	6	10·1
February	116	13	11·2
March	91	4	4·3
April	64	2	3·1
May	57	2	3·5
June	68	4	5·8

The writer is much indebted to Dr. M. L. Bhatia, ex-Entomologist, Department of Agriculture, Bihar, Sabour, for suggesting the problem and giving generous help and guidance.

Entomological Section,
Bihar Agricultural College,
Sabour, B. LAL.
February 13, 1946.

1. Crawford, J. C., *Proc. U.S.N. Mus.*, 1912, **42**, 7. 2. Ayyar, T. V. R., *Rept. Proc. Fourth Entom. Mtg. Pusa*, 1921, 365. 3. Krishnamurti, B. *Entom. Ser. Bull. No.* 9, *Dept. Agric. Mysore. State*, 1932. 4. Hem Singh Pruthi and Mani, M. S., *Miscellaneous Bull. No.* 30, 1940, p. 25, *I.C.A.R., New Delhi.*

SOME NOTES ON THE EMBRYO OF *CYMBIDIUM BICOLOR* LINDL.

THE two-celled proembryo of *Cymbidium bicolor* gives rise to an irregular mass of 5 to 10 cells; a cell situated towards the chalazal end of and belonging to this mass develops into a filamentous unicellular row of 6 to 10 cells; 2 or 3 terminal cells of this filament by further divisions form the actual embryonal mass. This course of development has been described in detail as the normal method for the embryo of *C. bicolor* (Swamy, 1942). During a re-examination of the slides two very interesting features were met with, which have been described blow:

(1) The zygote gives rise to an irregular mass of cells as has been said above. Hand in hand with this the cells of the inner integument become disintegrated so that there is free scope for the suspensor cells to expand in every direction. Even the filamentous proembryo develops not inside the cavity of the embryo-sac but in the empty space within the outer integument, so that the embryo may be said to develop outside the embryo-sac. While the suspensor cells elongate they do so by pushing through the disintegrating tissue and grow out into the space outside the embryo-sac. The embryo-sac with the degenerating primary endosperm nucleus may be seen below the developing embryo (Fig. 1).

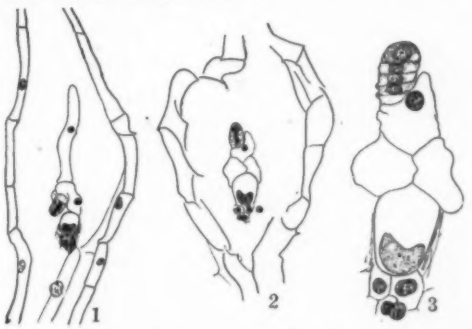


FIG. 1. L. s. of an ovule showing the proembryo developing outside the cavity of the embryo-sac; the degenerating primary endosperm nucleus may be seen inside the embryo-sac, × 80.

FIG. 2. L. s. of an ovule in which "inverted polarity" of the embryo is noticed, × 80.

FIG. 3. Embryo and its surrounding structures enlarged from Fig. 2, × 200.

All figures are shown as the micropyle pointing away from the observer.

(2) A more interesting instance is what may be described as the "Inverted polarity of the embryo". It is a well-known feature that the radicle end of the embryo in the seed is directed towards the micropyle and the plumule towards the chalaza. This character can be universally and clearly demonstrated during the early stages of the embryonomy itself. In contradistinction to the normal disposition, in the present instance the filamentous proembryo was seen developing towards the micropylar end. The suspensor cells were as usual abutting the micropylar end of the embryo-sac (Figs. 2 and 3). Evidently here the prosuspensor cells may be assumed to have been formed in the characteristic method described for the species, but the filamentous proembryo, instead of developing from a cell situated towards the chalazal end, has developed from a cell situated towards the micropylar end of the irregular mass of cells. It could not be

determined, however, whether such "inverted" proembryo develops to maturity in the same disposition or whether the filamentous region curves down towards the chalaza during subsequent stages so that the fully formed embryo assumes the normal position.

The present author has not been able to verify if parallel instances have been recorded in literature. However, both kinds of abnormalities described at presnt are extremely rare among spermatophytes. The first kind of anomaly is noticed in more than 90 per cent. of the ovules of *C. bicolor*. The second kind, on the other hand, was seen only in two ovules, in each of which the embryo was in more or less the same stage of development.

Basavangudi,
Bangalore, B. G. L. SWAMY.
April 20, 1946.

Swamy, B. G. L., *Proc. Ind. Acad. Sci.*, B, 1942, **15**, 194-201.

ON A NEW SPECIES OF *ISACCOCIRRUS* FROM THE MADRAS BEACH

THREE species of *Saccocirrus* have been recorded from the Indian coast; *S. minor* and *S. cirratus* from the Madras beach (Aiyar and Alikunhi, 1944), and *S. krusadensis* from the Gulf of Manaar (Alikunhi, 1942). The present form, also from the Madras beach, is the next to be added to the genus from India and forms the subject-matter for this communication.

The worms occur in the inter-tidal zone but rarely; and each measuring 10 to 12 mm. in length, is pale white in colour. Segmentation is distinct, the number of segments varying from 50 to 70. The body gradually tapers to the hind end. The head is bluntly conical and has a pair of dark eyes and two long tentacles which have a pointed appearance owing to numerous constrictions (Fig. 1*a*). The nuchal organs are conspicuous, each in the form of an oval, richly ciliated depression narrowing abruptly to the outer border. Palpocils are few on the prostomium, tentacles and body-surface. Hypodermal glands are well developed. Examined in the fresh condition (without a coverslip) a prominent group of these glands is seen on either side in every segment. The last six or seven segments of the body are apodous and achætous. The pygidium is bifurcated; anal lobes are long, each provided with four to six adhesive pad-like pupillæ on its ventro-median aspect (Fig. 1*b*). Rod-shaped hypodermal glands are crowded on each papilla. Palpocils are numerous on the pygidial lobes. Each parapodium carries a bundle of eight or nine capillary bristles, all of which have their tips smooth and variously expanded.

The ampullæ of the head-cavity extend into the first setigerous segment. A conspicuous muscular pad is absent in the pharyngeal wall. Gonads are usually developed from the 18th or 20th segment backwards. In the male the sperms are slender and exhibit movement when pressed out. The arrangement of the nephridia, sperm-sacs and penes is similar to that in *S. minor*. The penis is thick-walled and supported by cuticular rods.

The present form differs from *S. minor* in the jointed appearance of the cephalic tentacles and in the bifurcated pygidium. It differs from *S. cirratus* in its smaller size and in the absence of anal cirri and the pharyngeal mus-

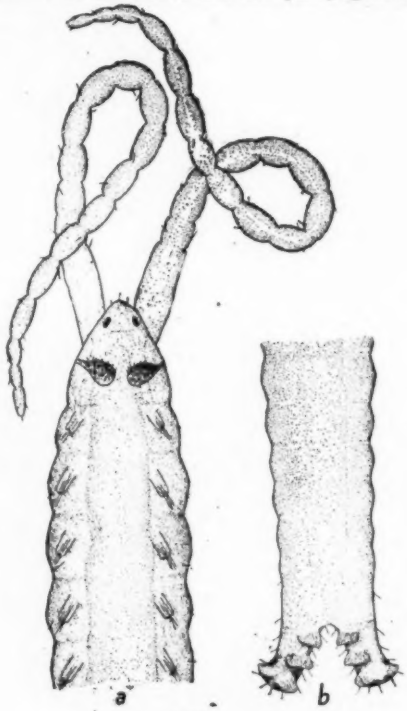


FIG. 1

Saccocirrus Orientalis, n. sp.; Cephalic and pygidial ends. a. × 54; b. ×90.

cular pad; and from *S. krusadensis* in the nature of the setæ besides the poorly developed pharyngeal musculature. The structure of the pygidium is very much similar to that in *S. papillocercus*, but in the nature of the setæ, pharyngeal musculature and size it closely resembles *S. minor*. It could be distinguished from all the known species of the genus by its peculiar smooth-tipped bristles, together with the bifurcated pygidium provided with anal lobes. It thus appears to be undescribed and I assign it to a new species under the name *Saccocirrus orientalis*.

My thanks are due to Prof. R. Gopala Aiyar and Prof. P. Narayana Menon for the kind help they extended to me.

Zoology Laboratory, Madras,
and
Dept. of Natural Science,
Maharaja's College,
Ernakulam, K. H. ALIKUNHI.
September 1, 1945.

1. Aiyar, R. G., and Alikunhi, K. H., "On Some Archiannelids of the Madras Coast," *Proc. Nat. Inst. Sci. India.*, 1944, **10**, No. 1. 2. Alikunhi, K. H., "Note on the occurrence of Archiannelids at Krusadai together with a description of an undescribed species of *Saccocirrus*", *Proc. Ind. Sci. Congr.*, 1942, 29th Session, Benares.

NOTES ON THE ANATOMY OF *HEMIONITIS ARIFOLIA* (BUR.) BEDD.

THE genus *Hemionitis*, one of the Polypodiaceæ, is represented in India, according to Beddome (1892, *Ferns of British India*, p. 414) by a single species *H. arifolia*, which occurs abundantly in South India and eastern Bengal. The species is a xerophyte and grows between rock crevices or as an epiphyte on tree trunks, the rhizome lying buried inside the humus on the bark and its crevices. No detailed description of this plant is available in any of the standard books on ferns. It was, therefore, thought that a comprehensive investigation of its life-history and anatomy would be interesting and profitable. The present note embodies the preliminary observations of such a study.

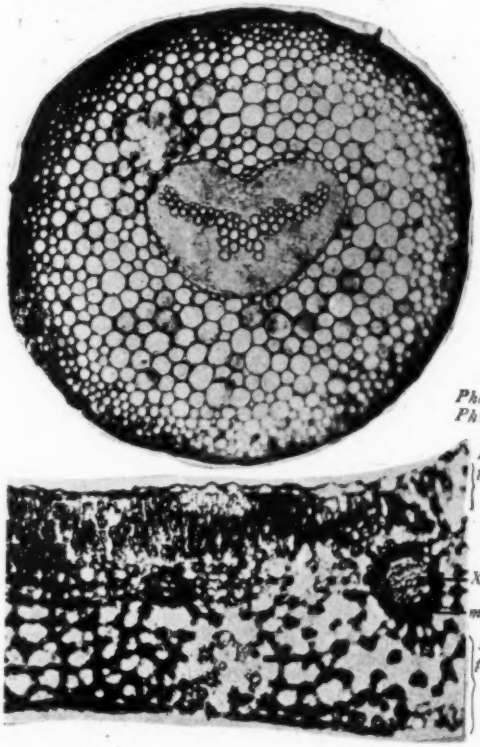
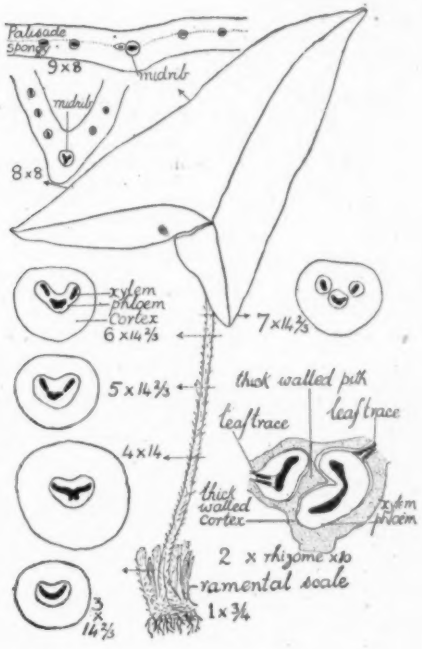


Photo. 1. Transverse section of petiole showing the x shaped xylem. Photo. 2. Transverse section of lamina showing the midrib, the palisade tissue, and the highly lacunar spongy parenchyma with stellately arranged cells.

The rhizome is rather stunted and densely covered by ramenta on the upper side, and by roots all over (Fig. 1). The petioles arise slightly oblique, are fairly long and carry at the end a single roughly trilobed lamina. The shape of this blade is extremely variable. The petiole is surrounded at its base by multicellular ramenta. The venation of the leaf is of the reticulate type resembling that of *Scolopendrium vulgare*. The reticulation is more dense at the periphery than at the centre. In addition to the single midrib there are three or five prominent lateral veins. The sporangia are distributed all over the under surface of the leaf along the veins.

Anatomy.—The solenostele of the rhizome is interrupted by one or two leaf-gaps. Occasionally even three leaf-gaps are present leading to a dictyostelic condition. More than three leaf-gaps have never been observed. The internal and external phlœms are quite clear and the pith and cortex are slightly thick-walled. The pericycle is one or two cells thick and phlobaphene does not appear in any con-



Figs. 1–9. *Hemionitis arifolia* (Burr.) Bedd 1. Rhizome with sterile leaf. 2. Transverse section of rhizome showing two leaf gaps, thick-walled cortex and pith, and leaf traces. 3–7. Transverse sections of the petiole taken at the different levels indicated by arrows in Fig. 1. Fig. 4 is from a different petiole and hence differs from the other sections in size. Figs. 8 and 9 are transverse sections of the blade taken at the levels indicated by arrows in Fig. 1. All diagrams are drawn from free-hand sections.

spicuous form.

The petiole is long, cylindrical and shows near the base a very shallow dorsal groove. At the very base a transverse section of the petiole shows a C-shaped strand (Fig. 3). Somewhere about the middle, the xylem of the

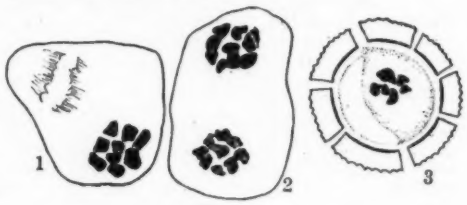
petiolar bundle becomes X-shaped in form—the upper limbs being longer and more spreading (Fig. 4 and Photo 1). The protoxylem groups—about four in number—are arranged along the margin of the upper bay. A little higher up the ends of the two upper limbs of the xylem are abstricted and the lower limbs gradually disappear (Figs. 5 and 6). Still higher up, but a little distance below the junction of the petiole and lamina, the two abstricted strands separate out and form two prominent lateral veins (Fig. 7). At this stage the xylems of the two meristeles are flat or slightly concave while the xylem of the main petiolar strand is V-shaped. Fig. 8 represents a section at a still higher level where more lateral veins have been formed and the midrib xylem has not yet lost its V-form. A section taken near the distal end of the blade shows the midrib and some of the lateral veins cut transversely, with their plate-like xylem. The upper and lower epidermis are covered by a thin layer of cutin. A layer of palisade tissue one or two cells thick, and a highly lacunar spongy parenchyma constitute the mesophyll (Fig. 9, Photo 2). The brief X-shaped condition of the petiolar bundle and the stellate pattern of the highly lacunar spongy mesophyll are amongst the interesting features of the plant.

A comprehensive study of the anatomy and cytology of the plant is under preparation and will be published elsewhere.

Department of Botany,
University of Lucknow, A. R. RAO.
April 20, 1946.

CHROMOSOME NUMBERS OF TWO MEMBERS OF THYMELÆACEÆ

THE writer wishes to record here the chromosome numbers of two members of the family Thymelæaceæ, namely, *Daphne cannabina* Wall., and *Wikstrœmia canescens* Meissn. The number has been counted from polar views at the metaphase of II meiotic division in the pollen mother cells in case of *Daphne cannabina* and from the first division in the uninucleate pollen grain in case of *Wikstrœmia canescens*. The haploid number of chromosomes in both the species is 9 (Figs. 1-3). The number of chromosomes of *Daphne cannabina* is determined for the first time while that of *Wikstrœmia canescens* was previously reported by Strasburger (1909).[3] The present count in the latter species by the writer confirms Strasburger's report.



FIGS. 1 and 2. *Daphne cannabina*. II metaphase in P.M.C. FIG. 3. *Wikstrœmia canescens*. I division in the uni-nucleate pollen grain. Figs. 1, 2 and 3, × 1700.

A list of chromosome numbers in the family Thymelæaceæ is given in the following table. The list includes eleven species belonging to three genera of Thymelæaceæ. From the same, it will be observed that $n=9$ is common to all the three genera. Two members included in the list, however, form an exception. They are *Daphne odora* and *Wikstrœmia indica*. In the former n is mostly 14 and occasionally 12 and 13, while in the latter it is 26. From the present available data on the chromosome number of the family Thymelæaceæ, it would appear that the basic number of the family is nine. Determination of chromosome number of the remaining species would be necessary to find out if the family is represented by more than one basic number.

The writer is indebted to Professor A. C. Joshi, D.SC., Government College, Lahore, for the material used in this investigation.

Species	Chromosome number n	Author
1. *Daphne mezereum* L.	9	Strasburger (1909)[3]
2. *Daphne alpina* L.	9	"
3. *Daphne pseudo-mezereum* A. Gr.	9	Osawa (1913)[2]
4. *Daphne kiusiana* Miq.	9	"
5. *Daphne odora* Thunb.	mostly 14, occasionally 12 and 13	Fuchs (1938)[1]
6. *Daphne Laureola* Linn.	9	"
7. *Daphne Cneorum* L.	9	"
8. *Daphne cannabina* Wall.	9	Venkateswarlu (present report)
9. *Wikstrœmia indica* C. A. Mey.	26	Winkler (1906)[4]
10. " " "	26	Strasburger (1909)[3]
11. *Wikstrœmia canescens* Meissn.	9	"
12. " "	9	Venkateswarlu (present report)
13. *Gnidia carinata* Thunb.	9	Strasburger (1909)[3]

Andhra University,
Guntur, J. VENKATESWARLU.
March 4, 1946.

1. Fuchs, A., *Osterr. Bot. Zeitschr.*, 1938, **87**. 2 Osawa, I., *Jour. Coll. Agri. Tokyo*, 1913, **4**. Strasburger, F, *Histol. Beitr.*, 1909, **7**. 4. Winkler, H., *Ann. Jard. bot. Buitenzorg.*, 1906, ser. 2, **5**.

REVIEWS

Electron Optics and the Electron Microscope. By V. K. Zworykin, G. A. Morton, E. G. Ramberg, J. Hiller and A. W. Vance. (John Wiley & Sons), August 1945. Pp. 766. Figs. 546. Price $10.00.

In this book the authors have dealt with the subject of electron optics and electron microscope in a very comprehensive manner. It is divided into two parts.

Part I contains a non-mathematical treatment of the subject with full technical details whereas in Part II the authors have dealt with mathematical theories of electron optics and its applications.

Part I opens with the physics of electron optics—the application of light optical theories and principles in electron optics. The different instruments—the electron microscopes of electric and magnetic types which utilise these principles are then described. After showing the distinct advantages of electron microscopes over light-optical microscopes the authors proceed to describe the different types of electron microscopes that are actually being used in different kinds of scientific researches. The book gives elaborate description of every part of the instrument in a very systematic way. Part I concludes with a discussion of the application of electron microscopes in various fields of scientific research—Chemical, Biochemical, Biological and others.

In Part II the authors have tried to give a full theoretical and mathematical background for the further study of the subject. Chapter I deals with the principles of light optics and shows how these are similar to electron optical principles and how they can be sucessfully applied to electron optics. Coming to the chapter on electron lenses the authors have given both theoretical and practical methods of determining the potential distributions of any two electrodes forming an electron lens. They have included in their discussion different types of lenses used for different purposes, their properties and performances. After describing electric lenses they have discussed the magnetic lenses and in this connection have dealt with magnetic fields, their properties and applications as lenses.

The later chapters are devoted to a discussion of the various defects of each type of lens, the causes of these defects and the methods of rectification. The last chapter deals with the mechanism of image formation in electron microscopes with different apertures. In this connection the authors have given an account of contour effects, the limits to resolution and the limit of recognition of small objects.

The authors have succeeded in helping the electron microscopist in understanding his instruments much better and using it to his best advantage. The reviewers have no hesitation in recommending this excellent book to the scientific worker dealing with electronic equipment in general and electron microscope in particular.

S. M. D. G.
J. C. G.

The Purification of Water Supplies. By George Bransby Williams. (Chapman & Hall, Ltd.), 1946. Pp. 95. Price 7/6 net.

In the far-off days when the twin steamers, the Peninsular and Oriental, used to handle the "ferry" traffic between Aden and Bombay, the captain of the Peninsular said to the present reviewer, then on his way to India for the first time, "You scientific men will be the death of the unfortunate Indian villager, he has grown to be immune to the danger of drinking dirty water and now with all your improvements you will destroy this immunity." Curiously the same possibility is referred to in the Epilogue to the volume under review. Recently also Mr. Gandhi remarks on this possible immunity. This does not prevent Mr. Bransby Williams from advocating the most up-to-date methods for water purification or Mr. Gandhi from urging the necessity for mental and bodily cleanliness. Insensitiveness to impurity of any kind is indeed a mark of a low standard of living, and there need be no hesitation, therefore, in advocating the adoption of the *best* without being constantly reminded that it may be "the enemy of the good". The reply to those who would argue that "India is a poor country and cannot afford these modern methods" is that it is better to provide even a fraction of the best which remains as a standard, than to supply a complete but inefficient whole. A small plant which will produce *some* pure water is better than a large installation which delivers a supply still not above suspicion.

Subject to the foregoing understanding Mr. Bransby Williams' book can be unreservedly welcomed. The general introductory matter is clear and readable and the methods and mechanisms described are carefully chosen and critically discussed. As an engineer he is to be congratulated on the soundness of Chapter I on the Chemistry of Water Treatment. The rather difficult explanations of hydrogen-ion concentration and the determination of pH are handled in a manner which will be welcomed both by beginners and by older workers in this field.

Chapter II on Coagulants is simply concentrated information, two pages consisting almost entirely of typical chemical equations. Chapter III deals with less quantitatively definable matters such as colloids, colour and the various micro-organisms occurring in waters. It might perhaps have been useful if some simple but characteristic diagrams of typical organisms could have been included.

The author modestly prefers to quote experienced authorities when he feels that the subject is better dealt with by direct quotation rather than by second-hand paraphrase. Thus the excellent Chapter IV on Self-Purification of Water quotes largely from the *American Manual of Waterworks Practice* and from Dr. Adeney's book on the *Dilution Method of Sewage Disposal*, following in this last respect the example of the present reviewer in his own publications.

In the more descriptive chapters on Chemical Precipitation, Softening of Water and Filtration, only the most recently adopted and proven plants and methods are described including flocculation mechanism, clarifying mechanism and the "accelator" process for the addition of softening chemicals. Base exchange methods are illustrated and mention is made of the use of organic bases capable of removing, on a laboratory scale at any rate, the solids from sea-water.

In the chapter on Filtration, including as it does, various mechanical filters, it would have been interesting to have the author's opinion of the use of "activated silt" for purification of water on the same principle as activated sludge is used to purify sewage. The idea was derived from the observation of the self-purification of the silt-laden waters of the Yangtze. The principle has been adopted at one of the Birmingham sewage works, loam being used as a vehicle for the purifying bacteria, and it is reported to have been used at more than one centre for the purification of water in place of mechanical filters. The type of mechanical filter using constantly moving sand is in fact a stage in the development of the idea.

The last long chapter on Sterilisation may be of special importance for India where cheap electrical power is becoming increasingly general. For many years the use of *ozone* which has long ago proved its efficiency at several centres in Holland and France has been held up on account of cost. Provided it can be supplied at a cost reasonably competitive with chlorine, its simplicity as compared with the many pitfalls attending the use of chlorine, well described in the present book, will give it easy preference.

In conclusion, it may be hoped that wide agreement may be shown by those in authority with the author's most wise and experienced recommendation that careful scientific investigation should precede every new scheme of water supply. In this investigation and subsequent control, as he rightly says, in the concluding sentence of his valuable and interesting book, "chemists, bacteriologists, engineers and waterworks managers, all need to take their full share".

G. J. F.

Electric Power System Control. By H. P. Young. Second Edition Revised. (Published by Chapman & Hall), 1946. Pp. xii + 369, with 249 Figs. 25 *sh.* net.

The book is one of a series of Monographs on Electrical Engineering brought out with the aim of providing practical engineers and advanced students with an up-to-date survey of a particular branch of the subject.

The subject-matter of the volume under review is one in which the advances made during the past few years, especially with the advent of the Grid System, have been phenomenal. In view of the fact that the literature dealing with these advances is not only voluminous but is also widely scattered in numerous journals, the presentation of the subject in a book form is most welcome.

The book opens with a chapter on the Parallel Operation of Generators and the characteristics of exciters, which are of fundamental importance to a clear understanding of some of the problems relating to system control.

This is followed by two chapters on the subject of Automatic Regulation of Synchronous Machines, both for voltage and power factor control—a subject which has an important bearing on system stability.

The fourth chapter deals with the Automatic Synchronizing of Generators, which is now more or less universally adopted in all large power stations with a view to avoid heavy current surges.

The next four chapters relate to Switchgear and associated problems such as control of short-circuit power by the use of reactors, different types of circuit breakers, power station switchgear arrangements, and short-circuit calculation. The special attention paid to the subject of Airblast Circuit Breakers which is being developed considerably during the last few years, is very appropriate and welcome. It seems probable that for switching at 33 Kv and above, especially in the larger sizes, the airblast circuit breaker might ultimately replace the oil circuit breaker, since it possesses the important advantage of containing no fuel which might assist in the spreading of a fire breaking out in the switch room. Also since air is employed as the extinguishing medium, fresh air is available for every operation, and owing to the shorter breaks and arcing times, the arc-energy is only a fraction of that in an oil circuit breaker, resulting in less burning of the contracts. The elimination of the necessity for changing the oil periodically and for draining the breaker before contact inspection can be made, will also greatly facilitate the problem of contact maintenance.

Chapters nine and ten are devoted to the important subject of Interconnection of Power Stations and Apparatus for Interconnector Control such as boosters, tap-changing gear, and induction regulators.

The book concludes with a chapter on the Principles of Automatic Supervisory Control, which provides a reliable means of affecting all system of operations from a distance and thereby permits the control to be centralized.

In a work of this kind, selection of material is no easy task if the size of the book is to be kept within reasonable limits. Obviously the author has mainly in view the needs of the practising engineers engaged in electric power system operation, and students specializing in power engineering.

There are over 200 line diagrams and photographs illustrating modern practice, many of

them being taken from the technical publications of leading manufacturers. The bibliography at the end of the book will be found very useful. The printing and get-up of the book are excellent and leave little to be desired. The book should find a place in the library of every electrical engineer.

H. N. RAMACHANDRA RAO.

Electrotechnics, Nos. 17 and 18. Journal of the Electrical Engineering Society, Indian Institute of Science, Bangalode. Edited by D. J. Badkas, M.Sc., A.I.Sc., A.M.I.E. (Ind.)

The issue under review is a combined number for 1944 and 1945, and contains many articles of interest to the electrical engineers. The distinguished contributors include the late Professor J. K. Catterson-Smith, Professor S. P. Chakravarti and Brigadier H. H. Berridge (I.E.M.E.).

It is difficult to pick out for special mention any article since they are all of high standard but mention may be made of the following articles as of special interest to Indian readers. 'On the possibility of an Ultra-short wave first grade broadcasting service in India,', 'Electric power development in C.P. and Berar', 'A high voltage testing laboratory for India', and 'The combustion gas cycle and its application'.

The Journal maintains its usual high standard both in its contents and get-up, and deserves to be read by all interested in the field of electrical engineering.

B. N. N.

SCIENCE NOTES AND NEWS

Hair-Ball in the Stomach of a Calf.—Mr. M. C. Nambudripad writes from Vilayur as follows :—

I READ with appreciation the letters published in the February and March issues of *Current Science*, in the above matter. I hope, the following observations will be of general interest.

In certain parts of Malabar, when cattle die, they are handed over to the *Pariahs*. As they cut open the abdomen of the dead animals, they sometimes come across such hair-balls. I have, as a matter of fact, got such balls with me. The balls, however, are smaller in size than that described in the note in the February issue of *Current Science*.

The hair-ball has its use also, as a cure for ringworm in the head, with complete loss of hair from the infected parts. It is rubbed for some time daily in the affected places for some days, when tiny brownish hair will begin to appear. The rubbing may then be stopped. The new hair will gradually turn black and grow like ordinary hair.

Is it the mere rubbing that destroys the infection, or is it a special property of the hair-ball ?—I cannot say. There is room for research.

Sixth International Congress for Applied Mechanics.—In line with the decision reached at Cambridge in 1938, it is proposed that the Sixth International Congress for Applied Mechanics be held in Paris, from September 22 to September 29, 1946. The invitations to the Congress are extended on behalf of: l'Academie des Sciences de l'Institut de France, la Direction des Relations culturelles, le Centre national de la Recherche scientifique, l'Institut de Mecanique de la Faculte des Sciences de Paris, la Societe francaise des Mecaniciens, l'Association technique Maritime et Aeronautique. The Congress will meet at the Sorbonne. The Congress will be divided into the following Sections: (1) Structures, Elasticity, Plasticity; (2) Hydro- and Aerodynamics, Hydraulics; (3) Solid Dynamics, Vibration and Sound, Friction and Lubrication; (4) Thermodynamics, Heat Transfer, Combustion, Fundamentals of Nuclear Energy. Besides the papers presented in these Sections, a number of General Lectures will be given on subjects of current interest. The titles of these Lectures will be made known in a later notice. Those who desire to become members of the Congress are requested to inform the Secretary-General as soon as possible of their intention to attend the Congress. They shall also indicate at the same time whether they wish to present a paper, and in what Section. This is required in order to facilitate the preparation of the program and the issuing of further notices. Communications are to be addressed to the Secretary-General of the Sixth International Congress for Applied Mechanics, Institut Henri-Poincare, 11, rue Pierre-Curie, PARIS (V).

Dr. F. Verdoorn, Managing Editor of *Chronica Botanica*, and Botanical Adviser to the Board for the Netherlands Indies, Surinam and Curacao, writes that since his previous reports (*Science*, Nov. 16 *et ante*) the death has been announced of the following biologists and agronomists in the Netherlands Indies:—Dr. J. D. F. Hardenberg, Director, Laboratory for Marine Biology, Batavia; Dr. Ir. Ch. Coster, Director, Experiment Station, West Java, Buitenzorg, formerly Chief Forester (executed July 1943, by the Japanese).

Scientists in the Far East.—According to word received from Singapore, Dr. M. A. Donk, Mycologist of the Buitenzorg Botanical Gardens, Dr. G. Giesberger, Microbiologist, and Dr. L. van der Piji, known for his work on floral biology, are in Singapore, in relatively good health. Mr. R. E. Holttum, Director of the Botanical Gardens of Singapore, is now in England; Dr. E. J. H. Corner is in charge of the Gardens during his absence. Dr. M. R.

Henderson, the Curator of the Gardens, who spent the war years in Newlands, South Africa, is on his way back to Singapore.

Of internationally known biologists in the Netherlands Indies, it may be of interest to state that the following were alive last October:—Miss Dr. B. Polak, Research Associate, Institute of Soils, Gen. Agric. Expt. Station, Buitenzorg; Dr. D. F. van Slooten, Chief, Herbarium, Government Botanic Gardens, Buitenzorg; Dr. H. J. Toxopeus, Head, Bot. Lab., Gen. Agric. Expt. Station, Buitenzorg; Dr. L. J. Toxopeus, Entomologist, Zoological Museum, Buitenzorg; M. A. Lieftinck, Chief, Zoological Museum, Buitenzorg; Prof. Dr. K. B. Boedijn, Director, College of Agriculture, Buitenzorg; Dr. M. Hille Ris Lambers, Geneticist, Expt. Station, Central and East Java, Malang.

A more or less complete list of scientists who were in the Netherlands Indies at the time of the Japanese invasion, with notes about their position, at that time, has been prepared by F. and J. G. Verdoorn and will be published shortly in *Science and Scientists in the Netherlands Indies*, edited by P. Honig and F. Verdoorn. Copies of this list, interleaved with blank paper, may be obtained without charge, from the Librarian, Central Depository Library for the Netherlands Indies, 10, Rockefeller Plaza, 14th Floor, New York 20, N.Y., or the Editor of *Chronica Botanica*, P.O. Box 151, Waltham 54, Mass.

GEOMAGNETIC STORMS

A considerable number of geomagnetic disturbances were recorded at the Alibag Magnetic Observatory during the quarter ending March 1946. Some details of those geomagnetic storms which have been classified as great or very great according to the standards of the Alibag Observatory have been given in the following table in which t_0, t represents time, ranges in the three different elements (D, H and V) of the earth's magnetic field as recorded at the Alibag Magnetic Observatory during the storms have also been given, D in minutes of arc and H and V in γ where $1\gamma = 10^{-5}$ gauss. The maximum k-index (k_m say) recorded during the storm has also been given in Table I below.

The storm of February 7-8, though cannoto be classified as very great from a consideration of ranges only, it was remarkable for a number of very short period fluctuations lasting for 2 to 3 hours each time. The vibrations in all the three elements were sometimes so rapid that it could not even excite the photographic paper properly and as a consequence the magnet traces were faint at certain times. This storm is no doubt connected with the passage of the great sunspot which crossed the central meridian on the 5th February 1946. It is reported that the usual aurora borealis have also been observed in high latitudes during the storm. A number of solar flares of the type which are usually associated with radio fade-outs were also recorded during the storm and also before its commencement.

The storm of March 28-29 is the most intense (from the standpoint of range measurement) of all storms recorded at Bombay during the last one hundred years. Previous to this the maximum range in H was 1023 attained during the storm of the 4th February 1872, when even aurora was seen at Bombay. Radio fade-outs and also disturbances in telegraphic transmissions are usually associated with this type of magnetic storms. This storm is also possibly associated with an active spot-group which crossed the sun's central meridian on the 27th March 1946. Distinct solar flare effects were, however, not noticed in the present case.

From the nature of the records it can be said that in the case of all the storms referred above their commencements have also been recorded practically simultaneously on all the different magnetic observatories of the world.

Date	t_0	t	T	R			k_m	Nature of commencement
				D	H	V		
1946	H. M.	H. M.	hrs.	min.	γ	γ		
January 3-4	13 37	16 00	4	8·7	278	43	8	Sudden
February 7-8	15 48	16 00	6	10·7	241	57	7	Sudden
March 9-11	17 30	20 00	6	6·2	158	61	6	Gradual
March 22-26	11 08	..	9	7·1	420	67	7	Sudden
March 28-29	12 05	13 30	6	22·8	1041	141	9	Sudden

(I.S.T.) of commencement of the storm and its intense phase respectively and T, the duration of the intense phase expressed in hours. The

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